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The Institute of British Foundrymen
The Institute of Vitreous Enamellers
The National Ironfounding Employers' Federation
The Welsh Engineers' and Founders' Association
and
The Foundry Trades' Equipment and Supplies Association

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Paying for the Best

Economic considerations arising from the peculiar characteristics of quantity production have been very much to the fore in recent years in the selection of engineering materials and the adoption of particular production methods in preference to others. The desperate striving for greater and still greater economy has undoubtedly done much to stimulate research and development work on the improvement of materials and processes and the reduction of costs, but a point now appears to have been reached at which something like a reaction is likely to occur. This state of affairs may be due in part to the general recovery in trade, but it appears to be more attributable to the realisation that there is an expanding market for the better quality product at a proportionately higher cost. This is not to say that the world has wearied of the mass-produced article, for there will naturally always be an enormous field for this type of product, but at the same time there are many purposes for which an increased expenditure on raw materials, leading to enhanced efficiency or reliability, is more than justified. In this connection, of course, the aircraft industry has led the way for many years; reliability is so absolutely essential here that cost virtually becomes a secondary consideration.

The effects of this tendency in the metallurgical industries may be observed in the attention which is being given to improved melting methods, to the elimination of undesirable non-metallic impurities, particularly in the case of steel, and to the more rigorous and precise metallurgical control and inspection of materials. As far as steel is concerned, the high-frequency induction furnace has gone a long way towards the improvement of the product in the directions of cleanliness and uniformity, while the mechanical properties have naturally been enhanced as the amounts of non-metallic inclusions have decreased. Where the highest degree of reliability is necessary or desirable, such steels will inevitably find a wide field of application and prove to be worth every penny they cost. Comparative freedom from inclusion has, of course, a most marked effect in improving the fatigue resistance, while exceptionally high tensile strengths may be obtained without undue loss of ductility or impact strength.

A parallel tendency may be observed to some extent in the iron foundry in respect of the increasing employment of pulverised fuel furnaces, but it is almost certainly only a question of time before the high-frequency induction type of furnace becomes established as a melting unit where quality and uniformity are considered to warrant the increased cost, and where engineers or buyers are sufficiently discerning to meet this cost in the knowledge that they are getting their money's worth. It is only by striving after the best and by a willingness to face the consequent increase in price that any material improvement in the more general run of engineering products may be effected in the long run.

Co-operation and Costs

Last week we had the privilege to be a guest at the annual banquet of the British Ironfounders' Association and associations allied to them. It was indeed pleasing to meet so many ironfoundry owners and directors who were palpably on excellent terms with each other, but it was impressed upon our minds that, whilst so much had been accomplished to bring about such healthy conditions in the light-castings industry, there was an almost overwhelming amount of work still to be done before the activities of the industry as a whole were adequately unified. The National Ironfounding Employers' Federation is a federation of local foundry owners' associations, and its power depends very largely on the strength of its component bodies. Generally speaking, although, of course, there are some very important exceptions, the members of this excellent organisation consist of detached foundries, or at least establishments where the foundry is a major department of the firm. If it be assumed that this type of foundry activity could be fused into one all-embracing federation, it would still leave untouched those very important foundries attached to steelworks, electrical engineers, the malleable foundries who manufacture a certain amount of grey-iron castings, and so forth. Yet any unaffiliated concern can—probably inadvertently—cause a sectional depression of prices by entering a new market or through a change in management or policy. The strength of the British Ironfounders' Association is due to the fact that its fundamental basis is that of ascertained costs, for the purpose of price stabilisation. Once this state of affairs is established, then competition between firms is one of efficiency, as the most efficient firm can make the most profit at any given price level. The same tendency is observable in a number of industries and this is bound to be the eventual basis

of all trade associations. Because of its ramifications, this is the greatest difficulty likely to be encountered in any serious effort that may be made to fuse the whole of the foundry industry—like the steel trade—into a comprehensive nation-wide employers' federation. For this reason we attach the greatest importance to the discussions on the provisional Report on Metal Costs which are taking place throughout the country and will occupy a good deal of our space in the near future. Customers of the foundry industry have no right to object to prices based on properly-ascertained costs plus a fair margin of profit so essential for the healthy development of this industry.

Correspondence

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Chromium in Malleable Iron

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—Through the medium of your columns I should like to express my sincere thanks for Miss Hall's letter published in your issue of November 29, in which she takes up the subject-matter of my letter published in your JOURNAL of August 30.

I was very pleased indeed to note that Miss Hall was able to correct erroneous impressions that I had gathered from other sources that some malleable-iron foundries in U.S.A had suffered appreciably by attempting to incorporate chromium in their iron. Miss Hall has, of course, the benefit of first-hand information.

With regard to the lady's statement that "my experience has been that most of them ridicule the idea, and the writer for sponsoring it." My own view is far removed from ridiculing the idea; in fact, I believe that for some purposes this chromium-malleable iron may develop. I indicated this in my letter.

I should like to make it perfectly clear that my sole reason for taking up this matter was that I felt that from the scant information contained in the published note, to which I referred in my previous letter, some foundrymen on this side might be tempted to try this without following the extreme caution which is necessary to avoid any of the chromium scrap or sprue becoming mixed with standard malleable. Incidentally, this would be a danger to anyone making chromium malleable even for special purposes.

I would also like to express my thanks to Miss Hall for enclosing a copy of the results obtained from the researches she carried out in connection with this alloy-malleable iron.

The 30-ton chromium-malleable iron to which I referred was made from cupola malleable iron. Since my original letter I have obtained even higher figures than these, but in view of the very adverse effect which chromium has on the elongation values, I ceased proceeding with the investigation, and I am afraid that I cannot even be induced to make these small percentage additions of chromium to the ladles of metal to prevent primary graphitisation in heavy sections such as Miss Hall speaks of, at least, not so far as our standard malleable iron is concerned. Our maximum figure for chromium specification in our malleable iron is 0.05 per cent., but actually it is rarely above 0.03 per cent.—Yours, etc.,

H. H. SHEPHERD,
Chief Metallurgist, Crane, Limited,
Ipswich.

Songs of the Sand.—Owing to difficulties in advertisement-space allocation, Stanza III of this cycle, promised by Messrs. J. Parish & Company, of Erith, Kent, on page 283 of our issue of November 1 to appear on December 6, had to be held over, and is now reproduced on page 381 of this issue.

District Presidents.—No. 14

BURNLEY SECTION OF THE INSTITUTE OF BRITISH FOUNDRYMEN

MR. F. HARRIS, the new President of the Burnley Section of the Institute of British Foundrymen, has spent the greater part of his life on the foundry floor. He commenced work at the age of 14 as an apprentice at the firm of J. Blyard & Sons' Guy Foundry, Padiham, where a very wide class of work was produced, such as general jobbing, textile, engineering and heating. Leaving there, he worked as a moulder in various branches of the industry until, at the

MR. F. HARRIS.

beginning of the war, he joined the Red Cross. He was transferred to the South Lancashire Regt., and later the Royal Engineers.

After three months in this regiment Mr. Harris was sent to France to work as a moulder. He was soon promoted to take charge of the non-ferrous side of a foundry engaged on locomotive work. Further promotion put him in charge of the whole foundry, including the ferrous department; about 40 moulders were employed.

After the war Mr. Harris returned to work as an ordinary moulder, until, in 1922, he obtained a situation as a foreman moulder. He is now foundry manager for Messrs. W. H. Dean & Son, Limited, Abbey Foundry, Whalley.

Tyne Shipbuilding

During November five shipbuilding orders were booked on Tyneside, compared with six in October. These two months have been the busiest this year. To date 17 vessels have been launched, and, as no further launches are expected this year, this will comprise the total for the whole of 1934. For 1933 the figure was only three vessels and four barges launched. There are to-day 18 vessels either building or to be laid down on the Tyne, with four or five others completing in the water. The work is divided among three firms—Messrs. Swan Hunter & Wigham Richardson, Limited, 10 vessels; Vickers Armstrongs, Limited, four vessels, and Messrs. R. & W. Hawthorn, Leslie & Company, Limited, four vessels.

MR. AND MRS. PATRICK SMITH, of Coats Street, Coatbridge, have celebrated their golden wedding. MR. Smith is a native of Coatbridge and, although 72 years of age, is still working in an ironworks near his home.

Complimentary Dinner to Mr. C. E. Williams

Tribute to the excellent work in the interests of foundrymen done by Mr. C. E. Williams, managing director of John Williams & Sons (Cardiff), Limited, and Past-President of the Institute of British Foundrymen, was paid at a complimentary dinner given to him at the Angel Hotel, Cardiff, on Friday night by the Wales, Monmouth, and West of England Branch of the Institute of British Foundrymen. Mr. Charles E. Richards, president of the branch, presided.

The spirit of the evening was typified in a letter from Mr. Roy Stubbs, President of the Institute, who wrote:—"So long as the Institute of British Foundrymen shall stand, and particularly the Wales and Monmouthshire Branch, his name will be built into its story as one who strove to make and keep it clean and fine in structure and in spirit." With this tribute he coupled the name of Mrs. Williams, whose sterling qualities, he added, had made her loved and respected by all.

Mr. Williams was presented with an illuminated address setting forth the appreciation of the branch of the manifold services rendered by him.

In handing it over Mr. Ben Hird (manager of the Cwmbran works of Guest, Keen & Nettlefolds) said the gift was some token of the esteem in which both Mr. and Mrs. Williams were held. The local branch had derived special pleasure and gained in prestige by the honour conferred upon Mr. Williams, whose work during his presidency had been the subject of special comment at the Manchester Conference this year.

The toast of "The Branch," proposed by Mrs. Roy Stubbs, Manchester, wife of this year's president of the Institute, was responded to by Mr. J. J. McClelland. Mrs. E. Rawden responded to the toast of "Ladies and Visitors," proposed by Mr. J. P. Galletly (manager of the Cardiff branch of Messrs. C. H. Bailey, Graham & Company, Limited), to which Mr. Sidney P. Richard also replied.

Non-Ferrous Foundry Fluxes

Messrs. Foundry Services, Limited, of Long Acre, Nechells, Birmingham, claim for a flux bearing the trade mark "Albral," which they manufacture and market, that an extensive investigation has shown that the alumina content is reduced from 0.07 to 0.02 per cent. when manufacturing aluminium-bronze castings. It is stated that it is equally satisfactory when used for manganese and silicon bronzes, whilst for use in connection with the remelting of aluminium residues, they have produced an "oxide remover." This material is being used by some firms for removing scars and other defects from aluminium die castings.

MR. PERCY LISTER, who for the past ten years has acted as managing director of Messrs. R. A. Lister & Company, Limited, of Dursley (Glos), has been appointed chairman of the company in succession to the late Mr. Austin Lister, who died last October. Mr. Lister is a grandson of the late Sir Ashton Lister, the founder, and until his death in 1929 the chairman, of the firm.

THE EXTENSIONS to the boiler plant for North Wilford Power Station, Nottingham, consist of four powdered-fuel-fired International Combustion, Limited's, boilers, each of a normal continuous evaporation of 175,000 lbs. per hr. and maximum continuous evaporation of 200,000 lbs. per hr., the steam at the stop valve being 625 lbs. per sq. in. at a temperature of 800 to 850 deg. Fah., and the feed temperature 240 deg. Fah. The boilers are of the Lopulco steam-generator design, with a completely water-cooled combustion chamber of closely-spaced bare tubes, and having a water screen of wider-spaced tubes over the ash hopper.

Manganese Bronze and Brass*

By Wesley Lambert, C.B.E. (Consulting Metallurgist)
Past-President, Institute of British Foundrymen

Historical

By the courtesy of Mr. Bernard Parsons, Director, and Mr. J. E. Newson, Chief Metallurgist, of the Manganese Bronze & Brass Company, Limited, the author is able to record a few authentic historical facts relating to the early introduction of manganese bronze and brass. It would appear that the first public mention of manganese bronze is to be found in "The Times" of February 21, 1876, wherein is cited the results of mechanical tests carried out at the Royal Arsenal, Woolwich, on certain new alloys introduced by the late Mr. P. M. Parsons. Judging from the figures published, the alloys tested on this particular occasion were definitely of the "bronze" type, *i.e.*, they were essentially copper-rich copper-tin alloys, to which manganese was added, most probably in the form of ferro-manganese.

A great future was predicted for the Parsons alloys, and in "The Standard" of April 12, 1876, it was suggested that possible applications would be marine propellers, locomotive axle-boxes, pressure pumps, pump-rods, racers for

FIG. 1. — MANGANESE BRONZE, SHOWING A HOMOGENEOUS STRUCTURE, CONSISTING OF THE ALPHA CONSTITUENT. × 100.

gun-mountings, and numerous other parts where steel failed by corrosion, and even armour plate for warships. With the exception of the last application, the alloys have fulfilled the prediction in a remarkable manner.

From subsequent records, one gathers that the first noteworthy application of the copper-tin-manganese alloy was the fitting, in 1877, of babbitted bearing brasses to the engines of the s.s. "Gleneagles," which vessel in the following year won the "Ocean Race of Tea Clippers from China." In May, 1879, a comprehensive display of manganese bronze and brass products was exhibited at a meeting of the Institution of Civil Engineers at South Kensington Museum. The exhibits included rolled sheets, forged and rolled rods, wire, and castings for high pressure; also, a cycloidal propeller for a torpedo boat. "The Times" of October 20, 1879, describing a new yacht for the Czar of Russia, mentions the provision of a Parsons' metal four-bladed propeller of 16 ft. dia. and 20-ft. pitch. On February 18, 1881, the trial of the s.s. "Garth Castle" took place, this vessel being the first of the mercantile marine to be fitted with a propeller of the new metal. Two months later the new alloy superseded gun-metal for all future propellers for the British Admiralty.

One may infer that the development of the copper-*zinc*-manganese alloys was almost certainly contemporary with that of the copper-*tin*-manganese alloys, as the company founded in 1882 to manufacture the Parsons alloys was, and still is, called the Manganese & Brass Company. Of the two types of alloys, the bronze appears to have fallen out of favour, whereas the manganese brasses, now commonly referred to as "manganese bronze," rapidly became established and have long been regarded as among the most successful of the industrial high-duty alloys in everyday use.

Some Metallurgical Features of Manganese Bronze*

The composition of commercial manganese bronze will be found, in general, to be within the following limits:—

Copper	... ...	50 to 70 per cent.
Aluminium	...	Traces to 5 ,,
Tin	... ...	Traces to 1½ ,,
Iron	... ...	Traces to 2 ,,
Manganese	...	Traces to 5 ,,
Nickel	... ...	Traces to 3 ,,
Zinc	... ...	Remainder.

Lead, arsenic, bismuth, antimony and sulphur, even in small quantities, are undesirable constituents. The composition, the character of the microstructure, the grain size, the state of cleanliness of the metal, and the freedom from gas and "draws," are the important factors which determine the strength and suitability of a manganese bronze.

The manganese bronzes used for industrial purposes fall into three categories, distinguished by their microstructure. These three classes are designated:—(1) Alloys of alpha structure; (2) alloys of alpha-beta structure, and (3) alloys of beta structure. Alloys of all three types are in use for the manufacture of rod and sheet, but alloys of alpha microstructure are rarely, if ever, used for founding castings to shape.

Under the microscope, suitably-prepared annealed specimens of the three categories of alloys will show, in the case of the alloys of the first and third type, a ground mass of a single-phase constituent consisting of a solid solution of zinc in excess of copper; whereas, the alloys of the second category reveal a duplex structure consisting of the two microconstituents, alpha and beta, the former separating out from solid solution from the latter during the cooling of the alloy.

The proportion of zinc to copper, the percentage amounts of other metals present, and the rate of cooling are the dominating factors which determine the ultimate microstructure of any particular manganese bronze. The influence of even only small percentages of additional metals upon the microstructure of a copper-zinc alloy may be very marked. In general, the ordinary metals found in a complex brass supplement the normal effect of zinc; aluminium and silicon are particularly active in this respect, and tend appreciably to disturb the normal relationship existing in copper-zinc alloys between composition and microstructure.

It is essential, therefore, when attempting to compound a complex bronze of a definite microstructure, to take this fact into consideration. A copper-zinc alloy of the alpha-phase may be readily converted into one of the alpha-beta type by the addition of metals other than zinc; likewise, an alpha-beta alloy into one of the beta type, or even a beta alloy into the brittle beta-gamma phase; alpha plus gamma, however, cannot exist in the same alloy.

Given the coefficient of zinc or copper equivalence, as the case may be, for each of the added metals—provided that the quantity of a metal is within certain limits—the micrographical constitution of any complex brass may be ascertained by the use of simple formulæ.

The selection of the most desirable metals, as also the determination of their several percentages, in order to secure the desired microstructure and properties for a special duty alloy, particularly within the province of the metallurgist, involves time and much costly research to arrive at the best data.

Characteristics of Cast Alloys of the Alpha Phase

As previously indicated, copper-zinc alloys of the alpha phase, which are in perfect internal equilibrium, are of a homogeneous single-phase structure. Under ordinary conditions of cooling, however, the alloys are not truly homogeneous, but show the well-known "cored" structure, which may be regarded as their chief characteristic when viewed under the microscope. During solidification, the first crystallites formed are much richer in copper than the mixture, *per se*, and as crystallisation progresses, the portions solidifying are successively poorer in copper and richer in zinc than those which preceded

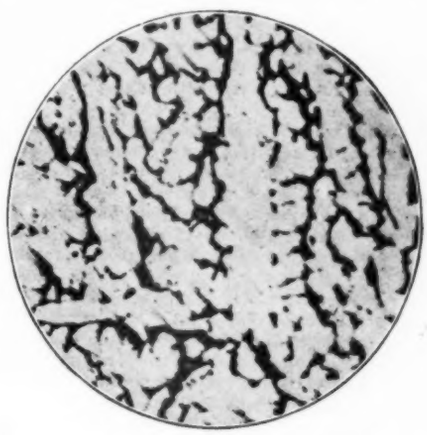

FIG. 2. — MANGANESE BRONZE, SHOWING A DUPLEX STRUCTURE OF ALPHA PLUS BETA (70 TO 75 PER CENT. ALPHA). × 100.

them. Each crystal grain presents a more or less regular gradation from centre to boundaries, the centre being richer in copper and the boundaries richer in zinc, than any other portion of the crystal. If the composition of the alloy approaches 36.5 per cent. of zinc, the boundaries of a crystal grain may become rich enough in zinc to show evidence of the beta phase between the alpha crystals. The cores and also any beta constituent may be absorbed, and the alloy rendered homogeneous, by suitable annealing. The melting or freezing point of an alloy of alpha microstructure may be taken as being about 895 deg. C.; the highest figure of the three categories of alloys under consideration. All the alloys of this class are characterised by the qualities of toughness and ductility. At ordinary temperatures these qualities attain a maximum when the zinc content is round about 30 per cent. Fracture of these alloys rarely, if ever, reveals the boundaries of the crystals, hence, even in slowly-cooled metals, these alloys show an extremely close-grained fracture. The yield point, as also the breaking load of the copper-zinc alloys of alpha microstructure is low, rarely exceeding 8 to 9 tons per sq. in. for the yield, and 26 to 28 tons per sq. in. for the breaking load. By the addition of small percent-

* A Paper read before a joint meeting of the London Section of the Institute of Metals and the London Branch of the Institute of British Foundrymen, Mr. A. S. Beech presiding.

* The designation "manganese bronze," in all subsequent references, is to be understood to refer to those complex alloys of a copper-zinc basis, containing manganese, but more rightly described as manganese brass.

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ages of suitable metals, these figures may be conserved, coupled with an elongation figure of 50 to 60 per cent.

Characteristics of Cast Alloys of the Alpha-Beta Phase

Under the microscope the alloys of this type reveal a duplex structure of two micro-constituents, the alpha constituent appearing as long, irregular-shaped crystals, and the beta as somewhat larger polygonal crystals of more or less spherical proportions. In the alloys rich in copper, the beta constituent is often found at

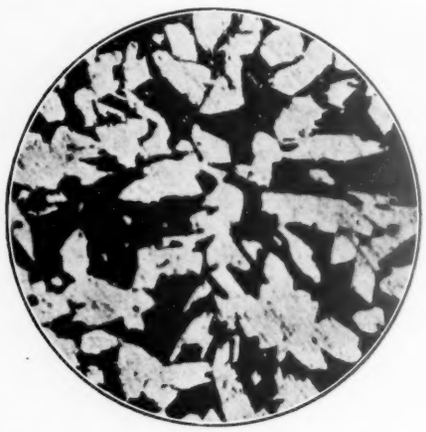

FIG. 3. — MANGANESE BRONZE, SHOWING A DUPLEX STRUCTURE OF ALPHA PLUS BETA (60 TO 65 PER CENT. ALPHA). × 100.

the boundaries of the somewhat tortuous alpha crystals. In the alloys rich in zinc, the beta crystals appear as massive polygons, at the boundaries of which alpha of various shapes and thickness segregates. Otherwise, the alpha constituent reveals itself in the body of the beta grains, often occurring in characteristic feathery forms.

As in the case of the alpha alloys, the microstructure of the alpha-beta alloys is influenced by the rate of cooling. When an alpha-beta alloy solidifies, the solid metal, at temperatures immediately below the freezing temperature, is entirely of the beta phase, which on cooling to a certain definite temperature, dependent upon the chemical composition, commences to break up into a duplex structure. Should the cooling be too rapid, however, the alpha and beta phases will not be in complete equilibrium; the alpha phase will be deficient in amount, and the beta phase will be too rich in copper. Suitable annealing will enable the beta phase to throw out its excess of copper in the form of crystals of the alpha constituent.

The amount of beta showing in a micro-specimen of a copper-zinc alloy when in complete equilibrium, is proportional to the amount of zinc in excess of 36.5 per cent. Thus an alloy with a zinc content of 36.5 per cent. of zinc exhibits no beta constituent. An alloy having a zinc content of 46.5 per cent. will consist wholly of the beta constituent. The quenching or very rapid cooling of an alpha-beta alloy *before* it has had time to throw out the alpha constituent may result in the formation of a homogeneous beta structure to the exclusion of any trace of the alpha constituent, notwithstanding that the alloy has the chemical composition associated with an alpha-beta metal.

A content of 1 per cent. of tin is specified by the British Admiralty in the specification governing the acceptance of high-tensile brasses of the alpha-beta type. The presence of the tin is considered to render the alloy more immune from the action of sea water. According to Desch, the tin is shared about equally between the alpha and the beta micro-constituents. In a correctly-compounded manganese bronze, the presence of tin in such proportion as that mentioned is not revealed under the microscope. Increase of tin beyond 1.4 per cent. is inadvisable, as, when this percentage is exceeded, a segregate of Cu_3Sn may be detected. The melting or freezing point of alloys of the alpha-beta type may be taken as about 875 deg. C.

In physical properties, the alpha-beta alloys are intermediate between an all-apha and an all-beta brass, varying between the soft, tough and ductile alpha brasses, and the hard and more brittle beta alloys. By suitably modifying the composition of the copper-zinc alloys of duplex structure by small percentages of selected additional metals, a combination of the most desirable properties of each of the single-phase alloys can be secured. Alpha-beta brasses can be worked either hot or cold.

Characteristics of the Cast Alloys of the Beta Phase

The beta phase of the copper-zinc series is a wholly homogeneous solid solution of zinc in copper. Unlike the alpha constituent, it does not show any distinct evidence of a cored structure. Under the microscope, the etched metal reveals itself as a single constituent, consisting of massive, more or less regularly formed, polygonal crystals—octahedrons of the monometric system; the diversity of colour of the exposed crystal surfaces of an etched micro-specimen being dependent upon the particular orientation of the individual crystals. The limiting figures comprising the beta range of the copper-zinc alloys are 46.5 to 49.0 per cent. of zinc. At temperatures just below the freezing point, however, alloys with as little as 40 per cent. of zinc are in the beta phase. It is advisable, therefore, whenever the true character of an alloy is sought, to see that a specimen has been slowly cooled from the molten condition or that it has been subsequently annealed.

The melting or freezing point of alloys in the beta phase may be taken as about 860 deg. C. The beta alloys comprise those alloys having both the highest percentage of zinc and the lowest freezing point of the industrial copper-zinc alloys. Except in those cases where the zinc is in part replaced by an appreciable quantity of aluminium and manganese, these alloys are liable to fracture under shock to a greater degree than the alloys of either the alpha or the alpha-beta series. When a beta metal is fractured,

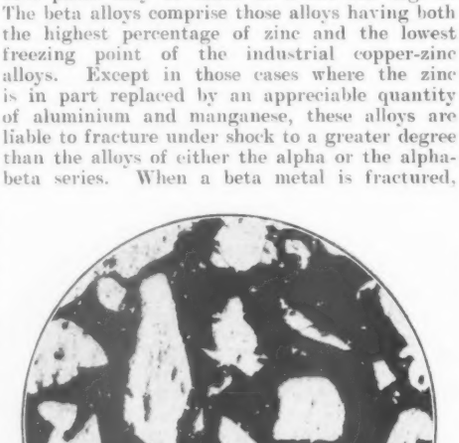

FIG. 4. — MANGANESE BRONZE, SHOWING A DUPLEX STRUCTURE OF ALPHA PLUS BETA (40 TO 50 PER CENT. ALPHA). × 100.

the rupture, in some cases, follows round the boundaries of the grains. It is from this fact that the grain size of the beta alloys appears to the uninformed to be coarser than the grain of a fractured alpha or alpha-beta alloy of the same grain size. When beta metals are very slowly cooled or annealed there is a tendency for the crystal grains to grow to a large size by absorption of adjacent crystals—with little mutual cohesion. Especially so is this the case if the metal has been subjected to the effect of chill or cold work previous to annealing. In such cases, the strength and ductility of the metal may be adversely affected.

The size of the grains in beta alloys is often variable over a small area, thus very fine and very coarse grains may appear abruptly side by side. This condition has only occasionally been observed in large castings of alpha-beta metal. By additions of small quantities of suitable metals, the yield and breaking loads of the beta class of alloy as-cast may be raised to 30 tons per sq. in. yield and to 55 tons per sq. in.

FIG. 5. — MANGANESE BRONZE, SHOWING A DUPLEX STRUCTURE OF ALPHA PLUS BETA (25 TO 30 PER CENT. ALPHA). × 100.

break. Such high-tensile alloys are, however, very sensitive, and any slight out-of-balance in composition, or error in manipulation, may prove disastrous. Moreover, it must be borne in mind that with alloys of the beta category, a gamma phase immediately follows the beta, and the slightest error of judgment in compounding these alloys may result in the presence of traces of the very brittle gamma constituent, thus rendering the metal definitely useless for anything other than remelting. Alloys of the beta phase can best be worked hot.

Foundry Technique

"If one were called upon to arrange the non-ferrous alloys according to the ease with which they can be successfully compounded and cast, manganese bronze would certainly not be listed near the top. In fact, many who have had dealings with this alloy would give it a place at the bottom, while some would go so far as to eliminate it altogether."—*Extract from contemporary journal.*

Manganese bronze, as a founding alloy, cannot be said to find universal favour. Admittedly, the successful founding of manganese bronze is not an easy proposition, as evidenced by the fact that even when the best foundry technique appears to have been followed, failures are not uncommon. Moreover, the proposition is one in which the remedial measures to be adopted to prevent a succession of failures do not readily suggest themselves. For the foregoing reasons, many non-ferrous founders consider they have justification for not being enamoured with manganese bronze, which, although grudgingly admitted by them to possess enhanced mechanical properties when compared with the best of the ordinary bronzes, they couple with aluminium bronze and regard the two alloys as the ugly sisters of the foundry.

First and foremost, it is essential that the founder should have a well-balanced alloy, skilfully compounded under strict supervision both as regards temperature and melting conditions. Moreover, the alloy must be of such a composition as not only to meet specification requirements in respect of mechanical tests, but must also have, as far as is possible, the desirable

properties of a good casting alloy without which successful foundry production cannot be assured. As the author has previously stressed in a former Paper on the manufacture of marine propellers, it is easily possible, by employing unskilled labour, the adoption of careless methods, a laxity of supervision, or a lack of experience, to fall very far short of success in the manufacture of good manganese bronze. Abnormal gassing, want of homogeneity in the mixing, high melting losses of one or more of the constituents, segregation and other troubles, are the defects often observable in an improperly

FIG. 6. — MANGANESE BRONZE, SHOWING A DUPLEX STRUCTURE OF ALPHA PLUS BETA (20 TO 25 PER CENT. ALPHA). × 100.

compounded alloy. It is obvious, therefore, that the inexperienced founder attempting to compound such a complex alloy is severely handicapped, even before proceeding with the making of castings. It is for this reason that the author strongly advises that stock ingot metal be purchased from a reputable manufacturer. Manganese bronze, in ingot form, corrected for normal melting losses, complying with almost any specification within reason, together with reliable information as to the best melting temperature and range of casting temperatures for the particular grade of alloy, are readily procurable from trade sources. To those, however, who are interested in gleaning something about the recognised "best practice" observed in compounding manganese bronze, attention may be directed to the alloys now obtainable in the market, such as manganese-copper, ferro-zinc, cupro-nickel, etc., alloys which admit, at comparatively low temperatures, of the introduction of metals which in the un-alloyed state have a very high melting point.

The following details cover the foundry procedure which should be observed in the founding of manganese bronze: In general, a contraction allowance of $\frac{1}{8}$ to $\frac{3}{16}$ in. to the foot should be allowed on patterns. On surfaces of medium-size castings which have to be machined, the following machining allowances are advised: $\frac{1}{16}$ to $\frac{1}{8}$ in. on faces cast downwards, $\frac{1}{8}$ to $\frac{3}{16}$ in. on side faces, and $\frac{3}{16}$ to $\frac{3}{8}$ in. on top faces. Small castings may be cast in green sand, rammed fairly stiff, adequately vented, and dusted lightly with either lime or plumbago. Large castings should be made, preferably, in well-dried moulds; the surfaces lightly brushed with a thin coating of plumbago dressing, made up in the proportion of 2 lbs. blacklead, 1 oz. core gum and sufficient water to form a thin wash. All cores should be free venting. Surfaces that are required to be quite clean should, whenever practicable, be cast face downwards. The use of denseners is, in some instances, almost imperative. Provision must be made for liberal feeding heads—these should be so located as to be most effective. All heads should be so fashioned and dimensioned as to preclude the possibility of a head "setting" prematurely before the casting itself is completely satisfied. Feeding with hot metal is often necessary, hence the advisability of keeping heads "open" with a "cover" of dry charcoal powder. Small runners should be employed. It is desirable, whenever possible, to "gate-in" at the bottom of a mould, the intake being as small as practicable having due regard to the proportionate size of the casting. When teeming, the down runner should be kept full of metal to exclude air. A dirt-trap or sump should be fashioned at the bottom of the down runner; this will serve also to prevent splashing and "shotting" of the molten metal as the alloy enters the actual mould.

For castings required to give the maximum tests, clean approved metal is essential. No scrap other than that of the same type should be used in admixture with new metal. Mixed clean scrap, such as heads, runners and ingotted swarf —the latter having been first magnetted before remelting—may be used in a proportion of two parts by weight of new metal to one of scrap. Manganese bronze in ingot form, as purchased from the trade, is corrected for normal melting losses, and, this being so, mixed metal charges of scrap and new metal, in the case of castings for which the maximum tests are not specified, will not require to be doctored by any "additions," providing that the above ratio of scrap to new metal is maintained, and that care is observed to avoid any abnormal "losses" by the undue exposure of the molten charge.

Small quantities of manganese bronze may be melted in plumbago crucibles either in coke-fired pot furnaces with natural draft, or in tilting furnaces of the usual type employed in non-ferrous metal melting. Large quantities can be more conveniently melted in open-hearth coal- or oil-fired reverberatory furnaces. When charging a crucible, care must be taken that no metal projects above the top of the vessel. The charge may with advantage be "covered" with a few pieces of hot dried stick-charcoal. This precaution, however, may be dispensed with if the best melting technique is always observed. The charge should be melted at as low a temperature as is consistent with rapid melting. Every endeavour should be made to obtain the whole of the metal required for any one casting, or set of castings, in the shortest time possible. The temperature during the melting operation should not, as a rule, exceed 980 deg. C., although a

FIG. 7. — MANGANESE BRONZE, SHOWING A DUPLEX STRUCTURE OF ALPHA PLUS BETA (15 TO 20 PER CENT. ALPHA). × 100.

slightly higher temperature may be advisable when melting only small quantities in crucibles.

Manganese bronze is not improved by being held in a liquid state longer than is definitely necessary. Overheating of the metal must be studiously avoided, as must also too frequent or violent stirring of the molten metal. Inattention to the foregoing points, results, by undue exposure of the melt, in gassing of the metal, the formation and inclusion of oxides, dross, etc., and, incidentally, to the alteration of the chemical composition of the alloy as originally compounded. Such happenings will seriously affect the mechanical properties of the bronze, and also the general soundness of a finished casting.

With some grades of manganese bronze, it is advisable to work to a fracture bar, in order to ensure that the melting losses have not been excessive, and also to serve as a guide in those cases where an addition of a small quantity of spelter, "to correct for loss," is deemed desirable. Standard fractures may be readily pre-

FIG. 8. — MANGANESE BRONZE, SHOWING A HOMOGENEOUS STRUCTURE, CONSISTING OF THE BETA CONSTITUENT. × 100.

pared by casting small quantities of a melt of well-mixed new ingot metal into small open-topped cast-iron moulds of the horizontal type. A small hand-ladle will suffice to convey sufficient metal from the bulk to fill a number of such moulds. The bars cast therein when cooled-out and broken across the centre, will reveal the characteristic "after one remelt fracture" of the particular grade of bronze supplied by the manufacturer, and will serve as standards by which subsequent melts can be judged, and the desirability of making any "additions" determined. Obviously, the bars, in all cases, should be cast as nearly as possible of uniform size, and the cooling conditions should be standardised.

Whenever founding manganese bronze, the mould should at all times be ready to receive the molten metal as soon as the latter is run down. The casting temperature should be as low as practicable, consistent with a sufficiently fluid metal throughout the casting operation. The actual temperature of the metal will naturally depend, in a large measure, upon the weight, the nature and dimensions of the casting, also upon the method of running, the size of the runner and of the in-gate. The mean temperature for any grade of manganese bronze will be represented by a casting temperature of 960 deg. C. In the case of crucible melting, when more than one pot is used to run down the required quantity of metal, the contents of each pot should be transferred to a preheated, lined, shank, or ladle, before finally teeming the metal into the mould. By doing so one ensures that, after gentle rabbling, the metal is averaged in composition throughout the mass. The surface of the molten metal should be carefully skimmed free from dross, etc., the lip of the container should be brushed clean, and the temperature of the metal should be accurately determined by the insertion of a pyrometer. Skimming of the surface of the molten metal and temperature observations, in the case of larger charges from furnace tappings, are likewise desirable.

The founder must of necessity take into consideration not only the gross weight, but also the nature of the casting to be produced, particularly in regard to thickness of sections, area

(*Concluded on page* 372.)

Life of Grate Castings

The behaviour of several cast irons when used as grate bars in boiler firing, has been studied by R. Zech and E. Piwowarsky.* The object of this investigation was first to determine the most appropriate composition with regard to the total carbon and phosphorus contents and then, if possible, to improve this standard composition by moderate additions of nickel, chromium and molybdenum.

The melts were made in an electric-arc furnace under a slag consisting of lime, silica sand, fluorspar and ground coke. The mixtures were made up of hematite, cold-blast pig, sheet and grey-iron scrap. The melting temperature was very high, over 1,450 deg. C. Grate plates measuring 18.1 by 8.65 by 0.394 in. were cast in green-sand moulds, and bars of 1.34 in. dia. and 25.2 in. long for the mechanical test in dry-sand moulds. The casting temperature was 1,350 deg. C. Besides the strength properties the tendency to growth and the degree of scaling were also determined in laboratory experiments. The life of the grate plates was tested by mounting them in a step grate of a modern boiler plant using brown coal as fuel. The coal contained: water 61.07, ash 2.23 and sulphur 0.28 per cent. The composition of the slag which formed in service was:—SiO_2 14.3, Fe_2O_3 19.2, Al_2O_3 6.05, CaO 45.2, MgO 4.11 and SO_3 11.23 per cent. The average temperature above the grate was 1,200 deg. C.

TABLE I.—*Composition and Properties of Alloy Cast Irons Used as Fire Bars.*

	High-carbon melts.					Low-carbon melts.				
Melt No.	28	29	30	31	32	35	36	37	38	39
T.C. .. .. per cent.	3.40	3.12	3.27	3.44	3.47	2.56	2.60	2.52	2.58	2.56
Gr. .. .. ,,	2.38	2.14	1.15	2.38	2.44	1.40	1.41	1.60	1.56	1.48
C.C. .. .. ,,	1.02	0.98	2.12	1.06	1.02	1.16	1.19	0.92	1.02	1.08
Mn .. .. ,,	0.70	0.59	0.60	0.51	0.57	0.46	0.52	0.49	0.51	0.50
Si .. .. ,,	1.50	1.22	1.55	1.50	1.46	1.04	1.45	1.50	1.04	1.36
P .. .. ,,	0.38	0.34	0.35	0.36	0.40	0.43	0.41	0.45	0.44	0.35
S .. .. ,,	0.07	0.03	0.05	0.05	0.06	0.06	0.05	0.03	0.03	0.05
Ni .. .. ,,	0.31	1.45	0.58	—	—	0.59	1.10	0.55	—	—
Cr .. .. ,,	0.12	0.34	1.23	—	0.35	0.28	0.38	1.06	—	0.34
Mo .. .. ,,	—	—	—	0.28	0.33	—	—	—	0.35	0.35
Tensile strength tons per sq. in.	12.65	17.3	11.11	12.32	11.72	13.1	16.2	19.06	19.11	21.85
Transverse strength ,, ,,	24.5	23.75	29.2	25.65	25.55	22.07	21.27	28.4	27.4	34.25
Deflection .. .. in.	0.285	0.256	0.25	0.360	0.364	0.289	0.269	0.339	0.271	0.366
Fracture	grey	grey	mottled	grey	grey	mottled to white				
Brinell hardness	221	221	312	196	196	239	212	217	207	213
Life in service .. hrs.	8,850	8,850	8,850	8,850	8,850	1,152	2,232	3,408	3,408	3,408
Growth .. per cent.	1.95	1.24	1.28	2.15	2.55	1.69	1.66	1.8	1.29	1.82
Scaling grams per sq. cm.	0.28	0.26	0.24	0.30	0.25	0.23	0.31	0.27	0.28	0.25

Two series of irons were first made containing 2.6 and 3.2 per cent. of carbon respectively, with phosphorus contents from 0.2 to 1.2 per cent. The other chemical composition was:—Mn about 0.5, Si 1.3 to 1.5, and S 0.05 to 0.08 per cent. The fracture of the high-carbon irons was grey, except the melt containing 1.17 per cent. P, which showed a mottled fracture. The structure consisted of lamellar pearlite, short graphite flakes and phosphide eutectic. The fracture of the low-carbon irons was white. The structure contained cementite, pearlite, phosphide eutectic and some graphite nests.

Of the high-carbon irons the melt containing 0.45 per cent. P showed the longest life in service with 3,024 working hours. Growth and scaling were at a minimum at this phosphorus content. While with further increasing phosphorus content the growth increased very rapidly and scaling more slowly, the life decreased only little up to 0.73 per cent. P (2,856 working hours). The micrographic examination of the grate plates after the service test showed that at the fire side the pearlite had decomposed, the net work of the phosphide eutectic was destroyed and the ground mass around the graphite flakes heavily oxidised. Sulphur prints showed that a sulphur pick-up had only taken place in the scaled and oxidised zones.

In the low-carbon series likewise the melt containing 0.4 per cent. P showed the longest life with 3,024 working hours. However, the life rapidly decreases with further increasing phosphorus content, whereas scaling increases more rapidly and the growth more slowly than with the high-carbon irons. After the service test the grate plates with 0.2, 0.8 and 1.1 per cent. P respectively, showed numerous cracks extending up to the centre of the plates. The pearlite had completely, the cementite partially decomposed; the graphite and ground mass were heavily oxidised. The better performance of the high-carbon irons is apparently due to the fact that scaling, which increases very rapidly with decreasing carbon content, has a greater effect upon the life than the growth.

The chemical composition and mechanical properties of the alloy irons in which the phosphorus was kept at the most favourable figure of 0.4 per cent., are given in Table I. It must be noted that due to service conditions, the grate plates of the melts Nos. 28 to 32 had to be removed from the fire grate after 8,850 working hours, though they were still quite serviceable. The low-carbon melts Nos. 35 to 39 showed the shortest life, which, at best, was only longer by 380 working hours when compared with the best unalloyed melt. The detrimental effect of low carbon content is so great as to neutralise completely the beneficial action of the alloying elements. Scaling was very great with these melts. The scale adhered pretty firmly, but numerous cracks extended from the fire side up to the centre of the plates. The appearance of the carbon-rich melts after the service test was very different. The melts Nos. 28 and 29 had suffered most, showing small initial cracks at the fire side which, however, had been luted by the scale and thus stopped. The best appearance had the mottled melt No. 30, which showed no cracks and only little scale. The melts Nos. 31 and 32 had a good appearance. Though the layer of scale was here deeper than with the other melts, the scale formed a tough mass welded firmly to the casting. The formation of cracks was moderate and confined to the surface of the plates.

The chemical analysis of the scale of the high-carbon melts showed that the contents of silicon, manganese, nickel and chromium had not changed materially. The phosphorus content had remained unaltered. The sulphur content had increased up to three times, whereas the carbon content had greatly diminished. Molybdenum seems to be more liable to burn off than nickel and chromium.

* "Die Giesserei," 1934, Nos. 37-38.

Manganese Bronze and Brass

(*Concluded from page 371.*)

of surfaces, and the relation of heavy and light portions of the several parts. Whenever a large casting has to be poured, it is recommended that a runner-box or basis should be arranged above the runner, and of such capacity as to hold at least one-third of the gross weight of the actual casting. When adopting this contrivance, it is advantageous to use a ball-plug wherewith to close the runner temporarily, and, when the receptacle above referred to is full, to raise the ball smoothly. The object of this arrangement is three-fold: firstly, good static pressure is available; secondly, it ensures that only clean metal enters the mould; thirdly, the down-runner can be kept full, and uniform pouring and the avoidance of much of the turbulence occasioned by the metal entering the mould can be ensured; freedom from entanglements of dross and "dead metal" thereby results, and the liability of the formation of "cold laps" is considerably reduced. Large moulds must be thoroughly dried, and after leaving the stove must be kept warm until immediately before the metal is teemed. The casting box must likewise be thoroughly dried and kept warm, the ball-plug being heated to redness and scaled if necessary.

The runner-box should be filled at the commencement of the pour; the level of the molten metal therein being kept constant for as long as practicable by a continuous flow of metal from the ladle, care being taken to see that the stream of metal does not impinge immediately over the orifice in the casting box.

Too rapid teeming of the metal into the mould must be guarded against and splashing avoided at all costs. A dry mould and a hot runner-box, rapid melting, careful skimming, correct casting temperature, good static pressure, slow, steady, continuous pouring, are pointers which lead to the production of sound castings.

When teeming a mould direct by hand, the lip of the container should be brought as near the mould as practicable, in order to avoid undue exposure of the molten metal. Large castings may with advantage be partially uncovered, and the mould relieved after the metal has completely set, in order to secure, by accelerated cooling, as fine a grain structure as possible, and to ensure the absence of abnormal internal stresses in the casting. Consideration, however, must be given to the necessity of allowing sufficient time to elapse in order that all thin sections may continue to feed uninterruptedly from the thicker sections and not *vice versa*, and also to the possibility of distortion setting up at the junction of parts of unequal section.

When making provision for test-bars to be cast integral with a casting, the "pockets" should be so formed, and placed in such positions, as to be least likely to entrap dross or dirty metal in the bars.

Notes From the Branches

London Branch.—The Annual Dinner will again be held at the Charing Cross Hotel, London, W.C.2. It is to take place on Wednesday, December 19. Sir Berkeley Sheffield, Bart., chairman of Southern Foundries, Limited, is to be the principal guest. Mr. Roy Stubbs will reply to the toast of "The Institute." Mr. Spence Thomas, Vice-President of the Iron and Steel Institute, is to propose the toast of "The London Branch."

A CLAIM BY THE UNIONS in the engineering industry for an advance in wages of 2d. an hour, with a corresponding increase in piece-rates, and for the revision of the 1931 overtime and night-shift agreement, will be presented to the employers at a conference in London on December 19.

Practical Hints for Making Alloyed Cast Iron

MR. RUSSELL'S PAPER ANALYSED

Mr. Russell's Paper on high-grade and alloyed cast-iron production was exceptionally well received by a large audience of London and East Midland foundrymen. It was printed in our last issue.

Heat-Treatment of "Ni-Resist" Castings

DR. T. B. CROW, opening the discussion, called attention to the surprisingly large loss in most of the metalloids and a gain in sulphur, and asked if the sulphur gain were due to accidental contact with coke. Further, he asked for particulars of the heat-treatment of the high-chromium "Ni-Resist" casting.

MR. P. A. RUSSELL replied that the proportion of nickel to chromium in the martensitic as-cast product varied very much with the job. He had mentioned the proportions as roughly 4 to 5 per cent. nickel and up to 1.5 per cent. chromium, depending very much on the hardness required and the amount of machining to be done. If there had to be a lot of machining, the chromium content must be kept lower.

With regard to the sulphur gain during crucible melting, he thought that some of it was due to accidental contact with coke, but he believed that it may be due largely to the affinity of nickel for sulphur. He had had experience of remelting nickel cast irons both austenitic and of low nickel content, in a crucible, and much to his surprise he had found that the sulphur had gradually built up until the graphitising effect of the nickel was more than counteracted by the chilling effect of the sulphur.

A week previously he had been more definite than he had been since concerning the heat-treatment of high-chromium austenitic irons; he had some work in progress in his department, and so far had found that, by heating to 850 deg., and allowing a sufficient time, according to the section of the casting, to ensure that the temperature was 850 deg. right through it, and then cooling in air, he had obtained the best results. But apparently there was some reduction of tensile strength due to that treatment.

Carburisation of Steel in the Cupola

MR. A. E. PEACE (President, East Midlands Branch) was surprised by Mr. Russell's remark concerning the absence of carburisation of steel in a cupola before it actually melted. He had never heard that stated before, and had never known anyone produce evidence to substantiate it, and, therefore, he asked if Mr. Russell had checked that result by evidence other than that of the particular case quoted. One knew definitely that steel would readily absorb carbon, and he could only conceive that if Mr. Russell had met the case where the steel had not absorbed carbon before melting, it must be due to the gas conditions in the cupola being definitely oxidising.

Mr. Peace joined issue with Mr. Russell in connection with the external sinking and internal porosity. It had been stated that with a change of carbon from above the eutectic point to below the eutectic point caused a change from external sinking to internal porosity. But Mr. Peace could not really see the difference between the phenomena of external sinking and internal porosity; they were both matters of shrinkage, in the one case the shrinkage being outside the casting, whereas in the other one left a defective zone inside the casting. Perhaps Mr. Russell would explain the point more fully and could give some assurance that he was right.

One had thought Mr. Russell was going to say that ladle additions were quite satisfactory, but he had qualified that statement by saying that one must weigh the ladle. He was definitely right there, because it seemed impossible to judge the content of metal in a ladle. But unless a foundry were operating to a considerable extent on alloy metals, it would appear that the weighing of the ladles would result in interference with production.

Two Types of Shrinkage

MR. RUSSELL said that although he had perhaps jumped to conclusions with regard to the absence of carburisation of steel in the cupola before it melted, he had confirmed the phenomenon by a second piece of steel, from the same blow as the first, and which was retrieved from the dump of a cupola which had been blown down. There was a deficiency of metal—the steel had not all melted. Admittedly the conditions in the cupola would be oxidising, because the phenomenon had occurred at the end of the blow. Candidly, he had expected to find that the steel was partly carburised, but in this instance it was not—and perhaps that was why the steel did not melt.

Discussing external sinking and internal porosity, he said it seemed there were two distinct manifestations of the property of shrinkage—the one internal and the other external. If one bored a hole in iron having carbon in excess of the eutectic amount, one found an open grain and definite voids in the centre; but if one ran in the same manner a cast of iron having carbon below the eutectic amount, the casting would be internally sound, but would be sunken externally. There seemed to be a very definite change from one characteristic to the other.

He felt very strongly about the necessity for weighing the ladle when making alloy additions. One could not produce alloy irons accurately otherwise.

Low Carburisation of Steel Confirmed

MR. C. H. KAIN (Past-President, London Branch) recalled some work he had carried out four or five years ago on the melting of steel in the cupola, and said that undoubtedly the steel did not absorb much carbon in the solid state. He believed that Field had also carried out some work in that connection ten years ago, as published in THE FOUNDRY TRADE JOURNAL. In his own work Mr. Kain had made a series of blows and had deliberately dropped the cupola half-way through the blow, and in every case the steel which had not melted had not absorbed carbon. He had also taken samples of metal from another steel melt by means of a ladle through the tuyeres and, surprisingly, the samples contained something less than 2 per cent. of carbon—about 1.6 per cent.; the carbon pick-up was very much less than was commonly thought.

Mr. Kain took exception to Mr. Russell's statement that when dealing with low-carbon high-quality iron it was necessary to use dry-sand moulding, because if green sand were used there would be local fusion by reason of the high pouring temperature. He pointed out that it was common practice to use green sand for steel castings, which were poured at even higher temperatures, and he could not see that the drying of the mould made the sand any more refractory; if the green sand would fuse he did not see why the dry sand should not also.

Finally, Mr. Kain asked if Mr. Russell had found any modification of the basic structure of the iron in the casting resulting from the use of denseners. Whilst they helped in securing soundness, they definitely caused a very considerable modification of the structure of the casting. Although the casting might still be grey, the structure in the portion adjacent to the densener was quite different from that in other portions; the carbon had a different form and the matrix of the iron was quite different, and where machining or any wear occurred the behaviour of the iron adjacent to the densener was different from its behaviour in parts away from the densener.

Dry-Sand Moulds and Refractories

MR. RUSSELL, dealing with the question of the use of dry-sand moulds, said that refractoriness was only one consideration. Admittedly, the refractoriness was not increased by drying, but it was improved by the application of a protective coating by the wet-blacking process. His company did not operate a steelfoundry, so that, as this practice had been developed from grey-iron practice, the drying methods he had mentioned had become necessary.

He had not carried out any micro-work on the effect of chills and denseners, but from the point of view of subsequent machining and wearing, he had seen very little traces of their effect, except, of course, when a densener was so heavy that it changed the combined carbon content, in which case, of course, one would expect to see a brighter and smoother surface. But he had used denseners on all sorts of castings which were subsequently machined, and could not detect the places in which those denseners were used. He agreed that if a chilling effect were obtained the structure was modified.

Overcoming Porosity

MR. M. RUSSELL (Scottish Branch) was glad to hear the author's statement that nickel alone did not produce a homogeneous structure. Dealing with porosity, he said that it occurred sometimes in the drag portion of castings, especially where there was $\frac{3}{16}$ in. or $\frac{1}{4}$ in. of machining, but did not occur throughout the casting. He asked if the author could suggest a remedy for it. In some castings the difficulty was overcome by adopting a centrifugal method of gating. The trouble was pronounced in chromium cast iron. He did not think that denseners or chills provided a remedy.

MR. P. A. RUSSELL said that the Report of the Sub-Committee to which he had referred dealt very largely with direct porosity, and the remedy lay in the metal control, by reducing the carbon and properly balancing the silicon. The low-silicon irons were definitely better, and that was where the value of nickel came in, in enabling the founder to run low-silicon iron and secure machinability without consequent increase of graphite size.

Austenitic Cast Irons

MR. F. HUDSON (Scottish Branch), discussing the production of austenitic cast iron, said that his firm had used a quantity of "Ni-resist" for making valves for all applications. He was particularly interested in the method described in the Paper for running valves, but his firm did not use such heavy risers as those described; they could make valves satisfactorily by using a far smaller riser if they cast the valves on end instead of on the flat. When they had first made "Ni-resist" they had used dry sand, but had discontinued that practice and found that they obtained as good or better castings in green-sand moulds. They had also tried cupola melting but had discontinued it and were concentrating entirely upon crucible melting for "Ni-resist," because they had found definitely that when that metal was produced from a crucible it had far less liquid shrinkage than when produced from the cupola. Another important point was that in the production of "Ni-resist" castings free from porosity he had found that he could not use a large percentage of scrap in the mixture. As a result, his firm tried to separate the types of castings into two grades—those which could be produced easily and which had an uniform section, and those which were more difficult to produce and had

varying sections. In the one case they used practically all scrap and in the other case they used practically new metal. Castings in the former were small rams and pump plungers, etc., which were plain cylindrical castings, whereas those in the latter category were miscellaneous castings required for valves, etc.

He asked if the crucible furnace used by Mr. Russell was coke-fired. His own firm used a crucible melt and obtained very much less loss in the crucible than in the cupola; indeed, he had only tried to use the cupola once but was so staggered by the melting losses that he had not used it since. It was also his experience that in crucible melting there was a tendency to lower carbons; but in his view that was an advantage, because the iron had a lesser range of liquid shrinkage and was not liable to suffer porosity in changes of section.

More Confirmation on Carburisation

Discussing the melting of steel in the cupola, Mr. Hudson recalled a Paper he had read to the Newcastle Branch of the Institute in 1924, showing the effect of melting conditions in the cupola, and said there was no doubt at all that carbon was not absorbed in the steel in a cupola before the steel was melted. In that Paper he had given a full series of micro sections. Probably that was the Paper to which Mr. Kain had referred, because Mr. Hudson did not think that Field had published any work in that direction.

MR. RUSSELL was particularly interested in the suggestion to cast valves on end instead of on the flat, and said he would certainly try it. His firm were essentially jobbing founders, so that they had to use customers' patterns, a fact which did increase their problems. Probably they could make things better from their own point of view if they had control of the pattern-making. Valves were among the castings which gave him least trouble—he played for "safety first"; these castings were expensive to produce, and the aim was to try to achieve success initially rather than to try to save an hour or two on production. If scrap were produced from them, there was difficulty in breaking it up; indeed, he kept one large casting to demonstrate toughness, and for the benefit of visitors pieces were broken from it by hammering.

Possibly green sand would give better results than dry sand when casting austenitic iron; but the dry sand was used from the point of view of safety.

Remelt and Shrinkage

It was interesting to hear that less shrinkage occurred when crucible melting was adopted as compared with cupola melting. The shrinkage problem in "Ni-Resist" was very largely wrapped up with the question of re-melt. He had tried to find out why that should be so, but could not, so that he had reached no definite conclusion; but he agreed that the more re-melt introduced, the greater were the difficulties. He had now arrived at a satisfactory correction for re-melting, taking into account the silicon and other losses to which he had referred, and was using re-melt up to 50 per cent. (It was pointed out in the Paper that re-melt up to 50 per cent. was used in the cupola charge.) That did help, because it gave consistency. If one made up from new materials, one was likely to get base iron melting at one time and N.C.C. melting at another.

When he had first tried cupola melting, he had obtained bad results, as had Mr. Hudson, but nowadays he was getting definitely regular results. These results depended largely on thoroughly preheating the cupola. The crucible furnace he used was coke fired.

DR. CROW asked if Mr. Russell knew more or less accurately the temperature of alloys such as "Ni-Resist" as they left the crucible, and whether he attempted to control it by the time factor or whether he used optical or other pyrometers.

MR. RUSSELL replied that he was not a great believer in optical pyrometers. His aim always was to get the temperature of the metal as high as possible—and he had never been able to get it hotter than he had wanted it. One of the reasons why he preferred the cupola to the crucible furnace was that he could get the metal hotter in the cupola.

MR. G. L. HARBACH (Newark) asked if there were not a greater tendency to blowholes as well as shrinkage troubles in low-carbon irons. He also asked what was the total-carbon content of "Ni-Resist." To obtain 3 per cent. T.C. in the final metal when using about 25 per cent. of non-ferrous metals obviously required 75 per cent. of 0.4 per cent. carbon, which usually could only be obtained with a hematite iron, with its very coarse graphite and low phosphorus.

Another question was whether annealing was recommended for "Ni-Resist" castings of very thin section. Theoretically, one would expect that the quicker cooling of the "Ni-Resist" should make the austenite more likely, and, therefore, one would expect it to be non-magnetic. Crucible-melted centrifugally-cast liners in "Ni-Resist" were almost invariably magnetic and unmachinable, but the annealing process corrected that and restored the non-magnetic condition. But by reason of the fact that they were magnetic as-cast, one was inclined to be very suspicious that the mixture had gone wrong.

MR. RUSSELL agreed that with low-carbon irons, particularly when melted under oxidising conditions, there was a greater tendency to the formation of oxide holes in the castings. The total carbon amounted usually to 2.8 or 3 per cent. in "Ni-Resist." The use of Ni-Cu-Cr pig, which contained very little carbon, did reduce the total carbon, but a little was picked up in the cupola. He had endeavoured to maintain the carbon as high as possible, from the point of view of reducing external shrinkage; but, having heard Mr. Hudson's remarks, he would try keeping it lower, in order to see whether the castings produced would be sounder internally.

The magnetic properties present before annealing were due to chromium carbides formed during the rapid cooling, he believed, these carbides being magnetic. The heat-treatment was necessary, not for the transformation of Martensite to austenite, but purely for the breaking down of the carbides of chromium that were formed. When the carbon went into the austenitic state, the magnetic properties were lost.

Spin Runners Reduce Porosity

MR. A. R. BARTLETT (Past-President, London Branch) proposed a vote of thanks to Mr. Russell for his very practical Paper.

Discussing his own experience, Mr. Bartlett said it had been the custom at his works some years ago to make some of the small important castings from metal melted in the crucible, because the carbon pick-up was small and a better product was obtained. But since the crucible furnaces were taken away and he had been working with cupolas only, he had found that by the judicious addition of steel the carbon content was kept low; a proportion of steel was used in practically every mixture.

Porosity had been seriously reduced by means of a spin runner, which gave an even distribution of all the products of the melt. For example, in the case of a circular casting a runner was provided all the way round and there was a riser at the far end of the runner; the line of travel of the metal was reversed by the ingates, which should be as numerous as possible so that the metal would be entering all round the casting. This method of running had proved to be very satisfactory.

Speaking of melting special alloy irons, Mr. Bartlett agreed that it was essential to preheat the cupola thoroughly. Some years ago he had tried to melt special alloy irons in a cupola after other irons had been melted, and also before other irons were melted, the purpose being to effect economy. His experience had indicated, however, that it was essential to run a cupola for the high-alloy irons only, and not to run other irons in the cupola, either before or after.

Rapid Fall in Temperature

There was also a very definite limit as to how much metal could be melted, run into one ladle and poured successfully, owing to the rapid loss of temperature. One difficulty in connection with the use of the optical pyrometer was that if it were read by different individuals the readings would differ; but he used an optical pyrometer and read it himself, so that he felt satisfied that he was getting comparative figures. The loss of temperature in the alloy irons was so rapid that he could not melt more than 2 tons and pour it successfully into small castings. The largest of the castings he had in mind weighed about 10 cwts., and some weighed only 7 or 8 lbs., and they were poured from the same ladle. In order to overcome the difficulties of pouring he had tried to put as many of the small castings as possible into one moulding box, connecting them by means of runners in order to give the metal the opportunity to get through. The metal used was an iron carrying 4.5 per cent. nickel, 1.5 per cent. chromium about 2.5 to 2.75 per cent. carbon, 0.6 or 0.65 per cent. silicon, 0.1 per cent. sulphur, 0.1 per cent. or a little less phosphorus, 0.1 per cent. cobalt and about 0.2 per cent. copper. A Brinell hardness of 760 was aimed at, and invariably that, or something very near it, was attained. The metallic and other losses in the cupola were rather high; the silicon loss was in the region of 20 per cent. in the smallest cupola at the works, and when a larger cupola was used the loss was even greater. The loss of manganese was 30 per cent.; there was a sulphur pick-up, though it was not serious; there was no loss of nickel (indeed, there was a percentage gain as compared with the elements in respect of which there were losses); the chromium loss was about 15 per cent.

DR. A. B. EVEREST, seconding the vote of thanks, commented upon Mr. Russell's statement that little had been published yet with regard to the practical side of the manufacture of special irons. He suggested that the reason was that where difficulties had arisen, and it had proved necessary to develop special methods of running and pouring castings, these methods had perhaps been regarded as trade secrets. Therefore, he expressed the opinion that the meeting owed a great debt of gratitude to Messrs. S. Russell & Sons for allowing Mr. Russell to publish all the information he had presented. He also said that the meeting was greatly indebted to Mr. Russell for the excellent manner in which he had prepared and presented his Paper, and had subsequently handled the discussion.

Ingots of Sponge Iron

C. A. BRACKELSBERG has patented in Germany (D.R.P. 578795) an improved process for obtaining sponge iron by the reduction of pulverulent or crushed ores or ore-coal mixtures and its subsequent desulphurisation while in the hot porous state by means of hydrogen, all in one operation. The heat evolved by hydrogen treatment raises the temperature sufficiently to allow the mass to be pressed into an ingot, whose direct production thus saves heat and metal losses.

Determination of P, As, V, W and Mo in Cast Iron and Steel

S. S. SHUKOVSKAJA and S. S. BERNSCHTEIN, in "Zavod Lab.," describe in detail the procedure for the determination of P in cast iron and steel by means of 8-hydroxyquinoline, a method which requires from 2½ to 3½ hr., and is applicable in the presence of SiO_2 and As. In the same periodical C. J. RABINOVITSCH deals with the determination of arsenic in cast iron and steel, and R. TAGER with the determination of vanadium in steel, while N. J. CHLOPIN discusses the determination of tungsten and molybdenum in ferro-alloys containing both.

Vitreous Enamelling of Cast Iron*

By B. B. Kent

However elaborate or costly a plant may be, the commercial success of vitreous enamelling cannot be achieved unless every operation is carefully checked and controlled and absolute cleanliness insisted upon. It is said of fire that it is a good servant, but a bad master; this can be truly said of an enamel plant. Unless everything is working smoothly, endless chaos will ensue, and what should have been a profitable business will become a financial calamity.

In the following Paper it is assumed that the raw material is brought into the plant as "Frit" of the leadless variety, of which there are several excellent brands now made in this country, on the Continent and in America. Unless an exceptionally large tonnage is used annually, it is inadvisable to manufacture this in the plant; the staff of smelters and chemists necessary for scientific control would bring the cost per pound far above the price at which it can be purchased from a specialised maker.

The process of enamelling can be divided into four:—(*a*) Cleaning the castings; (*b*) preparing the liquid enamel; (*c*) spraying and drying the castings; (*d*) fusing or burning. It is difficult to say which is the most important operation, for each must be done perfectly. A badly-cleaned casting will not produce a perfectly-enamelled article, however carefully the enamel has been prepared and, similarly, over-firing or under-firing will ruin the most carefully-processed part.

The first operation in the cleaning of the casting is the burning or annealing to remove any trapped gases that may be present. This operation also often reveals any slight flaws in the casting, and it is better for a casting to crack at this time than after labour has been spent on it for sandblasting or even spraying.

For this operation, the castings should be placed carefully on perrett bars and brought to a temperature of about 820 deg. C. for a period of about ten minutes. Considerable experience is necessary in arranging the load so as to obtain the maximum "throughput" and, at the same time, to avoid buckling or twisting.

If the castings be taken from the foundry immediately they are cast, it is possible to dispense with this annealing, unless pastel shades of enamel are to be applied.

Shot Blasting

Let us now consider the cleaning, or, as it is colloquially termed, "sandblasting" of the castings. The use of silica sand is totally unnecessary in modern enamelling, and, owing to its harmful effect on the workers, should not be introduced into the plant. Perfect results can be obtained by the use of angular "steel" grit of grades between numbers ten and sixteen. Faster cleaning is possible, and, if the abrasive material be removed from the machine after every hundred hours working and passed through a 30-mesh screen to remove the fine shot, even faster results will be obtained. This fine shot need not be wasted and can be transferred to ordinary low-pressure machines used for foundry cleaning purposes.

Another point in the favour of the use of "steel" grit is that the quantity of dust produced, in comparison with sand, is considerably less. Further, expense is saved in the handling and storing of the abrasive, as about one ton of shot will do the work of approximately ten to twelve tons of flint. Very little adjustment is necessary to convert machines from flint to shot, the only alteration being arrangement of the exhausting system to a point where the suction is just sufficient to remove the dust and allow the unbroken shot to fall back, by gravity, into the hopper.

Types of Plant Available

Great care should be taken in the choice of a sandblasting, or, to use the correct expression, shot-blasting equipment, as it is here that the greater part of the cost of enamelling lies. Three types of plant are usually available, and they are as follows:—

The house in which the operator works, wearing suitable protective clothing, comprising rubber gloves, rubber apron and a stout helmet fitted with glass windows protected by wire mesh into which fresh air is supplied by means of a small flexible tube.

The cabinet, which is worked from the outside, the operator manipulating the work through holes or curtains in the front, it only being necessary to have the hands protected by rubber gloves and goggles to protect the eyes from possible rebound of shot.

The rotary table, in which the work is placed on a revolving table and carried through curtains past four oscillating nozzles projecting the abrasive.

Unless particularly intricate castings are to be enamelled, by far the cheapest and fastest method is the rotary table. Even with complicated castings, it is a practical proposition to use a rotary table and to treat the edges afterwards by hand-finishing in the cabinet or house.

Provision of Spares

Whichever type of machine be used, the wear and tear will be found to be heavy and special precautions should be taken to ensure that spares are always kept in stock for immediate replacement, and every effort should be made to detect trouble before it actually arises.

As castings must be processed immediately after they are cleaned, it will be seen that a stoppage in this department will very soon bring the production of the whole plant to a standstill as a stock of cleaned castings cannot be kept to meet this contingency. Spares which should be always ready should consist of: a length of rubber hose; a supply of nozzles; wire gauze and glass cut to size; rubber curtains, and protective clothing. If several different machines be in use, they should all be converted to take the standardised hose fitting and nozzle.

The engineer in charge should examine the machines immediately they are stopped either for a meal-hour or change of shift and replace any part which it is seen will not last during the whole of the following shift. By these precautions, no interruptions will occur in the continuous working.

Life of Nozzles

Particular attention should also be paid to the selection of nozzles; usually the most expensive are, in the end, by far the cheapest, and if it is remembered that 85 cub. ft. of air is required to operate a ¼-in. nozzle and 191 cub. ft. for a ⅜-in. nozzle at 80 lbs. per sq. in., it may be seen that the quick wearing away means heavy expense and undue strain being put on the air compressors. If a machine shop be available, an excellent nozzle can be prepared for high-speed tool steel and, in normal use, this will last approximately 150 hrs. Some special alloy nozzles are on the market, but many of these are brittle and are easily broken by careless operators.

The Wheelabrator

It is highly probable that revolutionary changes will shortly be taking place in the operation of metal cleaning, due to the perfection of an apparatus by means of which the shot is impelled against the castings by centrifugal force instead of compressed air which, for successful operation, must be at a pressure of at least 65 lbs. per sq. in. By means of such apparatus, the power required for a similar operation is reduced about forty times, a 10 h.p. doing the work of 400 h.p. needed when compressed air is used.

The apparatus consists of a revolving wheel running at a speed of 1,750 r.p.m. and projecting the shot from about six apertures in the periphery, each aperture being fitted with a hardened blade to take care of the wear. The shot is introduced to the centre of the wheel by gravity through a 3-in. pipe and by means of a balancing shield the shot is only projected through the underside of the wheel and blasts a surface approximately 3 in. by 20 in. against 10 sq. inches when a nozzle is used. This apparatus can be introduced with equal success to a standard cabinet, table or room with very little modification.

Preparation of Enamel

For preparing the enamel, a special room should be set aside which should be well lighted, supplied with plenty of clean water and adequately drained. White-tiled walls and concrete floor with open gulleys form the best construction and all wasted enamel should be trapped in a sump before running to a drain to avoid stoppages. If definite cleanliness be insisted upon in this department, all this wasted enamel, consisting of washings from the mills, sieves and guns, can be salvaged and sent to be refritted and used for undercoats. It should be made a strict rule that, except to those employed in the actual preparation of the enamel, nobody should be allowed in the room.

For a small plant consisting of, say, four muffles, about nine grinding mills should be sufficient, but this will depend on the number of different types and colours of enamel being used; if the plant is entirely used for jobbing, at least double this number will be required. These mills will be required in several sizes and the complement should consist of: one of 1,000 lbs. capacity; four of 300 lbs.; two of 100 lbs., and two of 50 lbs. capacity, plus about four small porcelain pot mills for samples and experimental work.

In addition to the mills, the equipment should include: (*a*) two or three electric vibrating sieves and magnetic separators; (*b*) accurate scales both for bulk weighing and accurate checking; (*c*) fineness-testing equipment; (*d*) flow meters; (*e*) hydrometers, and, if possible, (*f*) a small gas or electric muffle to fire colour samples. A log book should be kept of all batches milled and suitably marked bins should be kept for storage of the different enamels.

At least once a month each mill should be carefully examined by inserting an electric lamp on a flexible lead to ascertain that the porcelain lining is intact, as, if this becomes worn, the enamel comes in contact with the iron of the outer casing and discoloration of the enamel will occur. The quantity of grinding pebbles or balls should be checked, all small or broken ones removed and the quantity made up until the mill is just over half full. It has been found that in grinding a batch of 300 lbs. of enamel 2 lbs. of pebbles are worn away and it is a good practice to add this weight of fresh pebbles to each batch.

Let us suppose that the enamel is required for a blue-mottled casting, then two different mills must be prepared in the proportion of about 300 lbs. of the blue or basic colour and 50 lbs. of mottling white. A suitable enamel can be prepared from the following formulæ:—

For the blue.—197½ lbs. white frit; 102½ lbs. clear frit; 15¾ lbs. vallendar clay; 2 lbs. 3½ ozs. black oxide; 2 lbs. 1 oz. blue oxide; 82½ lbs. water.

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* A Paper read before a joint meeting of the London and East Midlands Branches of the Institute of British Foundrymen. Mr. A. E. Peace presiding.

XUM

For the white.—50 lbs. white frit; 2½ lbs. vallendar clay; 1½ lbs. tin oxide or suitable opacifier; 15½ lbs. water.

The ingredients are introduced into the mill, preferably in the order stated, and ground down to about eight to ten units for the blue and 0 to one unit for the white. The exact signification of this fineness will be mentioned later.

Units

The procedure is to allow the mill to rotate for about 5 hrs., stop and take off a small sample for testing. On reaching a fineness of about 12 units, the mill is again stopped and a percentage of "scrapings" introduced, and the whole batch being further milled until, on testing, the required fineness is reached. In the making of this test, a small quantity of enamel is withdrawn, 50 c.c. is taken and washed with running water through a 150-mesh sieve, the residue remaining on the sieve is then dried and the powder obtained is poured carefully into a graduated tube, giving a direct reading in units.

Units are used rather than grams since the specific gravity of enamel varies considerably and would necessitate differently-calibrated tubes for each unit of differing specific gravity. The sample of enamel used for the fineness test is measured by volume, the final result being read from the calibrated tube in units of volume. There are several other tests available, but this has been found to be by far the most satisfactory and is now practically standard through the industry.

Grinding Technique

On reaching the point where the enamel is correctly ground, the cap is removed from the mill and a special plug cap fitted, and, by means of this, the enamel is run off into cans from which it is transferred over a magnetic separator through an electric vibrating sieve into storage bins, where it should be allowed to "age" for about 36 hrs. before using. The operation is speeded up if compressed air is supplied to the mill.

This enables the enamel to cool down, as it will have become quite hot, due to the friction caused through grinding. Whether further action takes place has never been satisfactorily approved, but it is believed that fermentation takes place caused by the organic inclusions in the clay, with a subsequent generation of weak acids, which neutralise a part of the alkalies in the solution, thereby improving plasticity.

Grinding time will depend considerably on the speed of the mills. Grinding too rapidly will overheat the enamel, whereas grinding too slowly is a waste of time. For a 300-lb. mill the speed should be in the neighbourhood of 35 r.p.m., for a 100-lb. mill 45 r.p.m., and smaller 60 r.p.m.

The enamel may be used milled down to one or two units, and slightly better results will be obtained, but much greater care is necessary in its application, and there will be practically no latitude in the thickness that it is sprayed and, if sprayed heavily, crazing will undoubtedly result.

Storage Problems

It is of utmost importance that all storage bins should be carefully marked, especially if a number of different types and grades of enamel are being used, and, when a multiplicity of colours is being handled, ordinary 7-lb. confectionary bottles will be found very suitable for storing various metallic oxides. These oxides are metallic oxides, different metals yielding different colours and, by a mixture, practically any shade can be obtained. The oxides of tin or antimony produce white, copper oxide green, cobalt oxide blue and cadmium oxides yellow.

Spraying Booths

Passing to the spraying line, here again it must be emphasised that no small detail may be neglected. In the lay-out of the line, it is best to have individual booths for each operator, each with its separate exhausting system and supplied with two spraying guns, one for the plain spraying and the other for mottling. At least 2 ft. 6 in. should divide each booth, especially if different colours are to be used. Booths should be constructed of strong galvanised iron and sharp corners avoided; baffles should be easily dismountable for cleaning.

If proper care be taken, the surplus enamel may be collected and returned to the mill-room and introduced into the next batch, as already explained. Special buckets should be kept for this, and the booths cleared at about hourly intervals, and at the end of each shift the booth should be swilled down and cleaned and the guns returned to their appropriate rack to be cleaned by someone skilled at this particular job.

Technique of Spraying

For ordinary plain colour work, a pressure of about 45 lbs. per sq. in. is required, whilst for mottling the pressure should be much lower and in the neighbourhood of 3 to 5 lbs. per sq. in. Both pressures should be kept constant or "orange peel," or rippling of the enamel, will result. This is best maintained by having an air receiver near to the line, with a reducing valve to bring the pressure from about 60 to 65 lbs. to the required pressure.

For the ordinary run of castings, a steel turning table should be used, mounted on roller bearings and having a number of holes drilled through the plate. By means of loose pointed steel pins, these may be arranged to support the work firmly, using a minimum number. Castings must be sprayed with an even movement, and the complete surface should be covered evenly, the casting revolved through 45 deg., sprayed over again and finally again sprayed around the edges. It is essential that a perfectly even coat be applied. If the casting is to be mottled, this could be done at the same time, and only in special circumstances is it necessary to dry the enamel before mottling.

Drying the Sprayed Castings

The next step is to dry the casting perfectly before it is introduced into the muffle, and, when treating cast iron, this is exceedingly important. If the casting be allowed to dry slowly, rust-spotting will appear, due to the water in the enamel coming in contact with the iron, whilst, at the same time, unless these are quickly dried and fused, a great deal of valuable space will be occupied in the drying room. The drying room can be constructed of asbestos boards on a wooden frame, and should be provided with sliding doors at the spray-booth side and the other side, which will be against the charging forks.

As well as a warm atmosphere, it is essential that there be a continuous air movement, while the floor should be perfectly flat to enable the work to be wheeled in and out by means of jacking trucks. If the heating of this room be effected by drawing the waste gases from the furnace underneath the floor, an excellent method is to exhaust the air from the bottom by means of a blower to blow it through the roof from a number of ducts, thereby creating the required air circulation. If the room be heated by means of an indirect dryer, then the air can be blown directly through the roof and walls, escaping by the doors, although it is advisable to have openings at the bottom leading into vertical exhausting pipes in case the doors are kept shut for any considerable time.

In spraying cast iron it is not always possible to pile the work on racks owing to its rust-spotting, and each piece must be transferred to the drying room as soon as possible. Rust-spotting will not be so likely to occur if the enamel is sprayed thickly, but this cure is naturally rather expensive. There are also a number of compounds on the market for preventing this rust-spotting, and even the addition of sodium nitrite will tend to prevent it, although this "doping" of the enamel is not advisable and the trouble should be rectified at its source.

Drying Racks

The construction of the drying racks will depend entirely on individual requirements, but are usually of hard wood on which two thin galvanised strips are fastened or sharp-pointed nails allowed to project through the cross strips. At least once per day these racks should be placed in a galvanised washing cabinet, approximately one dozen at a time, and, by means of a number of jets, given a good washing with high-pressure water. This will do a great deal to eliminate black specks and other foreign matter getting into the finished enamel.

Fusing

The last operation or fusing of the enamel is one that needs a certain amount of skill and experience, and whatever type of furnace be used, the loads must be carefully arranged, care being taken not to mix light sections with heavy pieces, otherwise the load will require varying times for fusing, and thin ones will need to be withdrawn earlier than the heavy ones. The time for fusing will depend entirely on the weight of the load charged, and while a single layer of flat work on knife-edge bars can be fused in about 12 min., a heavier hanging load of, say, 900 lbs. will require 25 min. Experienced fusers will be able to tell when the enamel is correctly fused down by inspecting the work through the peep-holes usually fitted to the charging door.

This Paper does not pretend to cover the details of the enamelling muffle, but it is sufficient to say that the temperature must be maintained at an even level and controlled by means of pyrometers, and care should be taken to see that the muffle is gastight, especially if oil is used as a heating medium. The best results are obtained if these muffles are maintained continuously at an even temperature and should only be shut down for examination and repair two or three times per year. In most works this is effected by shutting down at Whitsuntide and Christmastide.

In conclusion, it will be noticed that no reference has been made to the analysis of the iron. This is intentional, and if the dozen pieces which were exhibited at the meeting were examined, it would be seen that a commercial job had been made of each piece.

DISCUSSION

MR. F. O. BLACKWELL (Senior Vice-President, London Branch) said he believed that the wet process of enamelling cast iron was practically unknown in this country until 1925. Until that time the cast iron was enamelled by heating the casting and dusting powder on to it, then putting it back into the muffle for fusing—and poor-quality castings could be enamelled. The introduction of the wet process had involved a vast number of problems. The enameller, of course, was never wrong; if he produced a higher percentage of scrap, then it was not due to the enamel. It was said either that the sand blasting was inefficient, or that the machine shop had allowed some oil to get on to the castings, or that the foundry was at fault. Nevertheless, the improved effect in the enamelling of cast iron during the last few years was extraordinary, although the difficulty in producing the quality of enamelled cast iron with which the housewife had become familiar in various forms of articles, such as mangles, gas cookers, stoves, and so on, had been enormous, and the enamel was vastly different from that provided in 1926 or 1927. In those days, after a saucepan had been in use for a few weeks, involving drawing it across the top of the hot plate from time to time, the surface of the enamel seemed to be ruined. The juices from fruits when cooked had also ruined the enamel. The enamel provided nowadays, however, was really hard and durable.

XUM

With regard to the use of sieved grit in the low-pressure sand blast for cleaning castings, he said he had tried it for some months, but eventually had abandoned it, because the grit sent to the low-pressure sand blast—which was 30-lb. pressure—disappeared through the exhaust within a few minutes.

Sand Blasting

Cleaning castings by the rotary sand-blasting machine was the cheapest means of sand-blasting castings up to the moment, as the author had said, and by placing the nozzles at certain angles, one could to a limited extent clean the sides of the castings. There were certain castings which one could enamel immediately after they came from the rotary machine, but there were certain types of casting which must be taken to the room for sand blasting in particular places which otherwise would give constant trouble. A few years ago he had used the cabinet type of machine, but had since discarded it; in his opinion, it was a slow method of handling castings, and a very undesirable one. Therefore, he preferred the rotary machine and the room type.

The proprietor of the new American invention (Mr. Minich), referred to in the Paper, had arrived in England, and he had probably made arrangements for it to be made here. It was of vast interest, because, as the author had said, the bulk of the cost of enamelling cast iron was due to the sand blasting; there was a very high degree of destruction on the machine, and the cost of compressed air was high. If this new medium for blasting castings mechanically is really sound, then everyone in the trade would be falling over each other in their haste to get their machines converted.

MR. J. W. GARDOM (Past-President, London Branch), after having thanked Mr. Kent for giving a *résumé* of his works process, urged that in future, before members of the Institute visited any particular works about which they knew little, a Paper of this kind might be presented, for it would help them to such a great extent to understand the processes. Mr. Kent had spoken freely about his process, and it seemed that the enamelling trade was passing through the stage which the foundry trade had passed through about 15 years ago, *i.e.*, that at which secrets ceased to be secrets.

With regard to sand blasting, Mr. Gardom asked for some more information concerning the new invention (the "Wheelabrator"), because it seemed to him that it would be very difficult to alter the direction of the grit, which travelled in one direction only, there being no traverse.

Rotary End Blast Tables

He was inclined to disagree both with Mr. Kent and Mr. Blackwell in their reference to the advantages of the rotary blasting machine, because there was not a very economical usage of space of a circular table. For example, one could seat more people round a circular dining table than round a square table of similar area, but one found that there was not very much room for the necessary vessels and plates on the round table; the same argument applied to placing castings for sand blasting on a circular table. He would recommend, therefore, inspection of the sand-blasting plants working on the conveyor principle—some of which were operating in the Midlands, and one was operating in Scotland—in which castings travelled on a conveyor table through the cabinet constantly. In their passage through the cabinet they were sand blasted not only on the top and bottom, but at the sides as well, so that the whole casting was dealt with. This plant was not particularly suitable for handling long castings, but castings up to 12 inches long could be handled. There was also the continuous rotary-barrel type developed in Germany; while perhaps this was not suitable for vitreous enamelling work, it was very suitable for small work.

MR. KENT said that Mr. Gardom was correct in assuming that the invention referred to was the "Wheelabrator," which he had seen working in America during the summer. He had been shown the 400-h.p. compressor and the small motor driving the "Wheelabrator." So far as he could judge, the figures given with regard to it were correct. He had not seen an example of the conveyor type of sand-blasting machine, but, after all, it was a modification of the rotary-table machine.

MR. BLACKWELL, commenting on Mr. Gardom's criticism of the rotary-table machine, that there was not economical use of the space on the table, said that that depended on the man who loaded it. At his works there was a number of castings with open spaces in them, and when these and a quantity of smaller parts were on the table, it was very fully loaded indeed. Very detailed records were kept of the weight per hour, the abrasive used per lb. of casting blasted, and so on. He had investigated the conveyor type of sand blast, because his works had required some new sand blasts, and he was anxious to use the most economical type. For the high-pressure sand blasting required for castings to be enamelled, he believed the conveyor type was generally regarded as impossible, owing to the destructive pressure. For the low-pressure sand blasting of castings, for cleaning, he had arrived definitely at the conclusion that the conveyor type was not an economical proposition as compared with the rotary type. He would be quite happy if Mr. Gardom could convince him otherwise. He was aware that the conveyor type of plant was being used by certain firms in the Midlands for cleaning castings, and they were very pleased with it, but, after his investigations, he had wondered what type they had used previously.

MR. GARDOM: The rotary table!

MR. BLACKWELL commented that there were rotary tables *and* rotary tables.

MR. M. RUSSELL (Scottish Branch) exhibited two samples of an impeller, one of which was in the condition prior to sandblasting for enamelling, and the other in the enamelled condition, and he asked Mr. Kent's opinion of them. There was difficulty, he said, in persuading people in this country to take in hand jobbing work of that nature; in America, on the other hand, the demand for it was such that it paid some of the vitreous enamellers to do it as a jobbing line. The enamelled impeller he had exhibited showed pitting in the internal portion of the blade, and in places the enamelling was not regular. Porosity was apparent, though it was not apparent in the casting prior to enamelling—an indication that there were some oxides on the under skin of the enamel. He asked if there were firms in this country ready and willing to take in hand work of that nature—at a price, of course.

MR. KENT said it appeared that the enamelling had been done by the dusting process.

MR. RUSSELL agreed.

MR. KENT was of opinion that the enamelling could be done commercially by the wet process, though it would be well to take some of the sharp edges off the casting.

MR. BLACKWELL said that he would not accept an order to enamel by the dusting process the samples exhibited. The enamelling was obviously irregular, and the trouble with the dusting process was that one could not control to any great degree the thickness of the enamel. If the casting could be enamelled by the wet process the enamelling would be very much more regular. He was not suggesting, however, that he would accept the job, for at the moment he was overwhelmed.

MR. RUSSELL commented that most people gave recommendations, but none would take the work in hand.

MR. HARBACH asked if it were really a commercial proposition to enamel a casting such as the impeller exhibited.

MR. KENT said it was rather difficult to give a definite opinion without having a little more detailed knowledge of the service required of it; it was not an ideal casting for enamelling. However, if a job such as that turned up at his works he would do it and would not raise many queries about it. He offered to enamel it and send it to Mr. Russell.

Vote of Thanks

MR. P. A. RUSSELL, proposing a vote of thanks to Mr. Kent for his clear statement of the enamelling processes, was particularly interested in shot-blasting. The recent silicosis regulations of the Home Office, he said, had rendered the problem of shot-blasting a very acute one to all foundries, and it was particularly interesting to hear of Mr. Kent's experience, although he was using higher pressures than were normally required for ironfoundry work. It was perhaps astonishing that the Paper and the discussion did not deal largely with the metallurgical aspect of the enamelling problem. It had always been impressed upon him that the question of the class of iron to be used for enamelling was very important, and that unless one had the right grade the enamelling could not be done; but apparently that was not so.

MR. RUSSELL also expressed thanks to Mr. Blackwell for his interesting contributions to the discussion, particularly in pointing out the different types of enamelling.

MR. GOODWIN (East Midlands Branch), seconding the vote of thanks, said he would have welcomed some indication by Mr. Kent as to the best iron analysis for enamelling.

The vote of thanks was carried with acclamation.

MR. KENT, responding, expressed his pleasure that the secrecy that had been maintained hitherto concerning enamelling was dying; his own plant, at any rate, was open to inspection by any who would care to see it.

He was not a metallurgist, and he did not attach great importance to the analysis of the iron used for enamelling; he would enamel practically anything that came along, and preferred that it should be of fairly even section and free from sharp edges, so long as it was iron; he could not enamel slag, or enamel over blow-holes!

DURING A SITTING of the Free State Prices Commission recently, Mr. George Black, speaking on behalf of the Ironmongers Section of the Federated Employers, Limited, stated that since January 1, 1932, there had been an increase of 19½ per cent. in the price of Dublin-made piping, with the exception of 2-in. piping, on which the increase was 15 per cent. There had been an increase of 30 per cent. on fittings. At the end of 1932 special discount on large quantities was discontinued, due to the fact that delivery could not be made of 4 tons or over at any one time. Regarding a delay in the delivery of Liffey ranges from the Hammond Lane Foundry, Dublin, Mr. Black produced an order dated November 2, 1933, for twelve ranges, part of them needed hastily. Six ranges were delivered on December 14, 1933, and the other six were not delivered until March, 1934. On September 19 last 36 mantle registers were ordered and these had been cancelled this week owing to non-delivery. Mr. Buchanan, managing director of the Hammond Lane Foundry, told the Commission that the increase in prices were not made because of the tariffs. At one time they were making goods without any profit and towards the end of 1933 there was an increase of 7½ per cent. The reduction of discount was the same as that adopted by their competitors. They were working in competition with Scottish manufacturers. Some people had ordered large quantities of goods in order to get tonnage discount, knowing that delivery could not be made. For two years past his firm had to follow United Kingdom prices. The Hammond Lane foundry was one of the few firms in the Free State that had not taken advantage of the duties. He denied that there was undue delay at the foundry.

Modern Foundry Sand Practice

WEST YORKSHIRE DISCUSSION

Following the presidential address to the West Yorkshire Branch of the Institute of British Foundrymen, at Bradford, by Mr. A. W. Walker (Huddersfield),* Mr. F. K. Neath, of Keighley Laboratories, Limited, opened a general discussion on the subject of "Modern Foundry Sand Practice."

"Controlled" and "Synthetic" Sands

MR. NEATH dealt with the fundamental constitution of a moulding sand, namely, silica grains provided with a bonding material of a clay nature which, when suitably moistened, gave a material which can be rammed to shape and possesses refractoriness, permeability and reasonable strength. With regard to the silica grains, he remarked that the requirements in regard to uniformity and shape were well known amongst foundrymen, but what was often overlooked was the surface condition of the individual grains, an important matter, as this controlled the degree with which the bond adhered and so affected the strength of the sand. This point, said Mr. Neath, had been well brought out in Mr. J. J. Sheehan's recent Paper at the Manchester Conference. Another point was that with very uniformly-graded sands the presence of a small percentage of "fines" had been found desirable, particularly in steelfounding. With regard to the bond, a number of different "clay" materials, he said, were to be found in natural sands. The importance of hydrated iron oxide was well known. During the past fifteen years a great deal of work had been carried out and largely as a result of American conditions there had appeared what was termed "synthetic moulding sand." Mr. Neath deprecated the use of the term "synthetic," not because it was wrong—the term was satisfactory in some cases—but because the term attracted attention from the more important factor that such a sand was a *controlled moulding sand*. It was, he said, the study of the properties of moulding sands that led foundrymen to control the sands they used, in order to give uniform and improved results. The tests also enabled them to build up a sand from its elemental constituents, silica sand and bonding clay, and thus form, where necessary, a synthetic, or built-up, sand. To adopt the same principles with a naturally-occurring bonded sand enabled them to obtain equally successful results, and thus the term *controlled* sand was more desirable than synthetic. Such methods, proceeded the speaker, also permitted the use of old core sand, suitably re-bonded, which gave quite a useful saving.

Function of Coal Dust

With regard to coal dust, the latest views indicated that a refractory coating of fused coal was the major function rather than the gas-film theory, and this seemed to be in agreement with the work of Mr. Hird. Concluding his observations, Mr. Neath carried out a series of tests on samples of sand, including the compression test for bond strength, the permeability test, and moisture-content determination. These tests, he pointed out, were as recommended by the Institute of British Foundrymen's Technical Sub-Committee on Moulding Sands, in respect of which a questionnaire was shortly to be issued to members of the Institute, inviting their co-operation in the work of that Committee.

MR. S. CARTER (Huddersfield) said he felt they must all be agreed that if they had the facilities for using "synthetic" sand they would all be users of it because of its control. It would, he believed, do away with a lot of their troubles, but the average founder at present was unable to provide facilities for adequate testing. They would all like to aim at the ideal test for the average, but apart from the desirability of this scientifically-built-up and controlled sand he felt they had already in the Belgium sand the finest grade in existence, one grade only, though it was said to part with its bonding too easily. Did Mr. Neath know of any British sand that would compare with the benefits of the Belgian sand and get over that latter point? Mr. Neath (proceeded Mr. Carter) had said nothing on the question of alkalies in respect of fusibility of bonding material. They not only had a low melting point themselves, but formed compounds and lowered the general fusibility. A sand low in alkalies had definitely a use for steel castings. Mr. Carter said he thought they all of them tended to place too much reliance on the question of moisture content.

Cost of Control

MR. H. FORREST (Bradford) said one of the things he had tried to use was burnt core sand, in which they appeared to have a sand grain well coated with a material for building up synthetic sand, but there must be adequate facilities for control; particularly control of the moisture, bond and permeability. Mr. Forrest said he felt that any foundry which would acquire adequate test apparatus would find it profitable. A suitable outfit would not cost more than about £25 and it would save its cost in a year in saving sand which would otherwise be thrown out. The use of colloidal clays avoided the discarding of old sand. Colloidal-clay sands took a good impression and the edges stood up well.

Not Enthusiastic!

MR. A. S. WORCESTER said that looking at this matter purely from a foundryman's point of view he was not much impressed by this synthetic-sand idea. He had seen coal dust and sand in use with advantage, and he felt that was as near a synthetic sand as he had actually seen actually in use. Would one sand make the wide variety of products that the average jobbing foundry had to manufacture? Imagine the serious waste if one had to handle this sand every day. He questioned the value of the testing apparatus recommended so far as concerned its cost and working life in the average jobbing foundry.

The Time Factor

MR. VICTOR STOBIE (Past-President of the Institute) thought perhaps they were rather "splitting hairs" about this term "synthetic." It was a built-up moulding sand and perhaps they would be more correct, if they had to use the term at all, to call it synthetic moulding sand. If the fines were mixed with the clay one did not get the same contraction as with mere clay. In regard to moisture in moulding sand, if they took any dry colloidal-clay and sand mixture and add water and tried to develop the bond at once they had only themselves to blame if they were not satisfied with the result. The time factor entered into the bonding of clay.

MR. BRIAN BROADBENT (Huddersfield) said it was essential to have a sand known and controlled. The mixer should take a serious part in this matter. In regard to the ideal sand, it was evident that one must depend on more than one factor. The moisture factor was of little value unless backed up by permeability, bond strength, etc. Could Mr. Neath give what he considered an ideal sand in units of moisture, bond strength and permeability?

AUTHOR'S REPLY

MR. NEATH, replying to the general discussion, said he did not speak necessarily as an exponent of synthetic sands, but had been reviewing the claims made on their behalf. He did not suggest that the jobbing foundry should scrap its existing plant and instal new equipment without quite serious consideration, but if they could find any way of taking advantage of the knowledge that had been gained by tests and research to improve their own sand they would presumably desire to do so. In reply to Mr. Carter, Mr. Neath said he did not know of any British sand which could be considered identical or comparable with the Belgian sand, but that did not necessarily mean that such sands could not be imitated by blending, etc. He agreed that alkali content was important when considering fusibility of clay-bonding materials. With regard to moisture content, it was important to avoid excess moisture when adding a bonding material to an unbonded sand. Mr. Neath agreed that flowability was an important factor which would have to be considered more fully in the future when determining the required characteristics of a sand, particularly for machine moulding.

Use of Controlled Sands

Mr. Neath said he was afraid he could not agree with Mr. Worcester's views. After all, by sand research and sand testing they aimed at understanding the many factors involved in making moulds. He thought it would be agreed that "a devil you know is better than a devil you don't know," and the process "getting to know" had led to remarkable improvements and economies in some foundries. Surely the matter was worth further consideration? He would, however, like to point out to Mr. Worcester that it was not suggested that one sand alone would do for all types of casting, though one controlled sand may do for a good many types. The use of these tests may be too big a thing for some jobbing foundries, but there was no reason why the jobbing founder should not apply, so far as lay within his own scope, the ideas which had been developed. Mr. Neath said he entirely agreed with Mr. Stobie in the usefulness of the time factor in developing bond, in that when starting with a silica-sand base it had been found necessary to allow a few days' storage, etc., before the best results could be obtained. Of course, most foundries used a partially-bonded sand in the form of floor sand, and in this case the time factor did not seem to be so important. With regard to moisture content the best percentage was found by experiment, and the rapid-control test for moisture need only be comparative. In further answer to Mr. Broadbent, the values for the various tests varied with the type of sand, but the following figures could be taken as a general guide:—Moisture, 3 to 7 per cent.; bond strength, 4 to 6 lbs. per sq. in.; permeability, 40 to 50 c.c./min.

In reply to a series of written questions by Mr. Walker, Mr. Neath would say that permeability did not vary much with moisture over the useful range for a given sand. He did not think there should be any greater accumulation of silt with synthetic sand. Personally, he would like to know just what silt was, as there appeared to be a wide variety of views on that matter. Generally speaking, the permeability decreased with increased ramming density or increased bond strength, but the amount of such decrease depended on the constitution of the sand. The percentage of clay grade in many sands was of the order of 10 per cent., but higher percentages were found in a number of natural sands. Mr. Neath said he had not experienced scabbing with a sand having a high dry-bond strength other than what could be explained in a straightforward way.

A PARTY OF SEVEN Chinese engineers, including an assistant commissioner for transport in China, is touring this country's chief industrial districts. Two members of the party visited Cardiff Docks recently, and later were conducted over the Port Talbot steelworks of the British (Guest Keen Baldwins) Iron & Steel Company, Limited.

* FOUNDRY TRADE JOURNAL, November 22, 1934, page 329.

British Ironfounders' Association

ANNUAL DINNER

The Annual Dinner of the British Ironfounders' Association, the British Bath Manufacturers' Association and the National Light Castings Ironfounders' Federation took place at the Hotel Metropole, London, on Wednesday, December 5. There was a good attendance and the chair was taken by Mr. W. R. Blair, Chief Executive Officer of the British Ironfounders' Association.

The toast of "The Guests" was proposed by CAPTAIN H. J. KENNARD, R.N. (Carron Company), who said that the reorganisation of any trade could not be done without the co-operation of the distributors, and it was for that reason he welcomed so many representatives of the distributing trade to the dinner because it had concluded an agreement with the merchants, which on the whole appeared to be working satisfactorily. This agreement was noteworthy in that it was the first instance of a real joint endeavour between two sections of a trade, and as such it should constitute a model for future agreements.

The reply to the toast was given by MR. ALAN SHIRLAW (Southern Foundry, Croydon, and chairman of No. 5 Area).

Although his name was not on the programme, the chairman called upon Mr. Forbes Watson, who was associated with the National Light Castings Association many years ago, to make a few remarks. Mr. Forbes Watson, who was given an enthusiastic reception, is now Director

THE ANNUAL DINNER OF THE BRITISH IRONFOUNDERS' ASSOCIATION, BRITISH BATH MANUFACTURERS' ASSOCIATION, AND NATIONAL LIGHT CASTINGS IRONFOUNDERS' FEDERATION, PRESIDED OVER BY MR. W. R. BLAIR.

been due to the good will of the distributing trade that the task of the British Ironfounders' Association had been made comparatively easy.

MR. H. CHEETHAM (Messrs. Rowe Bros. & Company, Limited, and Vice-President, British Federation of Plumbers' Merchants' Associations), who replied to the toast, said that there were certain manufacturers and certain merchants who were very fond of associations as long as they themselves were outside, and were given the opportunity of living on the backs of those who were inside. Now and again we heard of legislation which might be forthcoming to enable that situation to be dealt with, and as one who knew the evils of price-cutting to the production side of the industry all he could say was that the sooner it came the better. He did not know how far that matter had progressed, but there should now be sufficient influence in the three associations whose guests they were that evening to give the movement a good heave forward.

SIR W. R. DUDLEY PRYKE, BT., who proposed "The B.I.A. and Kindred Organisations," complimented the B.I.A. on having recently con-

of the Confederation of Employers' Federations, and, although his speech was light in character to some extent, he ended up on a very serious note. Remarking that from the nature of his present duties, which brought him into contact with a very large number of industries, he was bound to take a broad view, he said there are at present some industries in this country which are not so prosperous as the industries represented that evening, yet it was upon the prosperity of those other industries that their own prosperity depended. Out of the 46-million population of this country, there were only 21 millions who did any work, and of those there were 17 millions who had not more than £250 a year, whilst there were 2¼ millions who could not find work. It was this which was the problem for this country. Indeed, in ten years' time there would be another million people asking for work. The export trade was essential to us, but, whereas the export trade of the world to-day was as large as it was before the war, our export trade was only 54 per cent. of what it was, and employment had been drifting to the non-exporting industries, which employed 30 per cent. of the people and had added one million to their numbers during the past 10 years. The exporting industries, on the other hand, were employing 200,000 less people, although during the past year the employment figures were much better than they were the year before. The fact was, that only in so far as we could sell goods abroad should we be able to maintain the standard of living and the high traditions of civilisation which we possessed, and how was that to be done? It would not be done by compulsory international 40-hr. weeks. He had spent the last 13 years going backwards and forwards to Geneva, and had not yet seen an agreement on hours of labour which he was prepared to sign, because none of these agreements meant the same to the Frenchmen as they meant to us, and until they did, he would have nothing to do with them. Nor would the position be improved by spending money through the Exchequer. Nationally, and through the local authorities, we had been going too far in that direction, and his own view was that it would only be by private enterprise and co-operation between all sections of industries that the country as a whole would again become prosperous.

An exceedingly pleasant evening was brought to a close by a whirlwind speech by MR. E. W. HOLLOWAY, of the I.F.A., who proposed "The Chairman," to which MR. BLAIR replied.

REPRESENTATIVES OF THE Blaenavon Council have had an interview with Mr. J. H. Lones, managing director of the Blaenavon Company, Limited, when, it is understood, the future of the firm's blast furnaces was under discussion.

H.M. THE KING has been graciously pleased to accept a proposal of the Royal Warrant Holders' Association that, as an expression of their loyalty and appreciation, and in celebration of the 25th year of His Majesty's reign, Royal Warrant Holders shall build, equip, furnish and endow a house for presentation to His Majesty. All materials and labour necessary to the building, equipment and furnishing of the house will be provided by holders of the Royal Warrant, who will also contribute to an endowment fund which will relieve the property of any charges in perpetuity.

XUM

This Week's News in Brief

Trade Talk

HINGES, LOCKS AND WINDOW FITTINGS, now imported by Palestine, are to be made shortly by the "Dlee" bucket factory, in Kiriat Arie, Tel Aviv.

SOME DAMAGE was done by a fire which broke out at the works of Messrs. G. M. Marchant, Limited, brassfounders, Folly Hall, Huddersfield. The cause of the fire is unknown.

AT A SITTING of the Falkirk Dean of Guild Court this week, a petition was presented by Messrs. R. & A. Main, Limited, Gothic Iron Works, Camelon, for permission to make an extension to the foundry premises. The petition was unanimously granted.

MESSRS. RANSOMES & RAPIER, LIMITED, who have long been associated with the irrigation works of the Egyptian Government, have been awarded the contract for the ironwork required for the remodelling of the Assiut Dam. The value of the contract is £135,000.

HERBERTSHIRE BRICKWORKS, situated in the western area of Denny, and owned by the Callendar Iron and Coal Company, Limited, Falkirk, was the scene of a somewhat alarming outbreak of fire as a result of which the engine house and its contents, including the electrical-generating plant, was destroyed.

THE EMPLOYEES OF THE Argus Foundry Company, Limited, Thornliebank, have allocated to infirmaries and other charitable institutions in the West of Scotland the sum of £48 6s. The employees in Messrs. Babcock & Wilcox, Limited, Dumbarton works have contributed £184 for the six months ended November 30.

AT THE ANNUAL GENERAL MEETING of the National Federation of Bridge and Structural Engineers, held at Grosvenor House, Park Lane, last Friday, Mr. E. A. Wilson (Archibald D. Dawnay & Sons, Limited) was re-elected chairman for the coming year, and Mr. W. T. Thornhill (Rubery, Owen & Company) vice-chairman.

ACCORDING TO Mr. A. H. Dierker, there are in Ohio, U.S.A., 584 establishments for the manufacture of castings of all sorts, nearly one-fifth of the foundries in the whole United States. These are located in 149 different cities and towns. The total value of foundry products made in Ohio will well exceed £20,000,000 annually.

IT HAS BEEN DECIDED by the Great Southern Railway of Ireland to build new coaches for the Kingstown-Cork mail service. The work, which will occupy at least a year, will be carried out at the company's works at Inchicore, and will give much needed employment. The coaches will be of the Pullman type, with large panoramic windows.

AFTER EXPERIMENTING for some time, the Singer Company, Clydebank, has commenced to produce some of the sewing-machine accessories in bakelite. Although work in bakelite has not begun on a large scale yet, more machines are being made to allow of extensions, and these will be installed early in the New Year, when more hands will be taken on.

THE MOTHERWELL BRIDGE & ENGINEERING COMPANY, LIMITED, have secured an important order from the Chinese Government Purchasing Commission for 50 steel bridges for shipment to China. The firm have at present on hand for the same clients 16 bridges. The contract was obtained against very keen competition and will now ensure full-time employment of the works until the middle of 1935.

MESSRS. HENRY ROBB, LIMITED, Victoria Shipyard, Leith, have secured an order from Coast Lines, Limited, for a third vessel of the fleet of coasters of which the "British Coast" was the first launched about a year ago. Since then Messrs. Robb have launched the "Atlantic Coast." These two vessels were the largest coastal ships in the country, but the new vessel is to be larger still, with a length of 350 ft. and a gross tonnage of 1,800.

ALL PARTS OF Glasgow Harbour have been busy during the past week, and dockers have been much in demand, overtime being necessary to cope with the work in hand. Heavy consignments of iron ore have been arriving at Rothesay dock and many thousands of tons of scrap and pig-iron have arrived at other parts of the harbour. The Clan Line steamer "Buteshire" shipped a number of locomotives at Stobcross Quay for delivery to the South African Railways.

IT IS OFFICIALLY ANNOUNCED that Messrs. Ramage & Ferguson, Limited, engineers and shipbuilders, of Leith are to be wound up. It is stated that the firm is quite solvent and that all creditors will receive payment in full. The firm has been of long standing and at one time had an extensive business which gave employment to a large number of men, but for a number of years the output has been comparatively small and for some time no new building orders have been received.

WORKMEN AT THE FOUNDRY in Athy, County Kildare, had a shock when a metal bar with which they were working exploded. The men had sorted out some scrap, and were carving through a brass bar when suddenly there was a violent explosion. Two of the workers were struck by small pieces of metal on the head and body, and had their faces badly lacerated. It is conjectured that the bar contained powder and that the friction of the saw caused it to detonate. It possibly had been there for several years.

THE PRESENTATION of ironfounders' prizes, diplomas and certificates took place in the Falkirk Technical School on December 4. Bailie Andrew Wallace presided, and was supported by Mr. John Brown, representing the British Ironfounders' Association, ex-Provost A. Logan, County Councillor G. MacLaren, the assistant director of education, the joint principals of continuation classes and the rector of the school. In the course of the report, which was presented by Mr. Walker, the Principal, it was stated that the attendance had been excellent: 68 per cent. of the foundry students made 90 per cent. or over of the possible hours of attendance. In connection with the moulding, ironfounding and patternmaking courses, new schemes of work were in operation to meet the present-day requirements of the local light-castings industry, and also the City and Guilds of London Institute Technological examinations. Students were represented for the first time in patternmaking and foundry practice and science. The record of awards included two City and Guilds of London certificates for patternmaking, foundry practice and science, 92 course certificates to foundry students and eight diplomas to students who have completed successfully a five-years' course of patternmaking, ironfounding, moulding, grate-fitting and steel metalwork.

Contracts Open

Cork, December 12.—Iron and steel stores, for the Cork Harbour Commissioners. The Engineer's Department, Harbour Office, Cork.

Kingsclere, December 18.—Supply and laying of 4,600 yds. 4-in. and 5,000 yds. of 3-in. cast-iron mains, with valves, etc., for the Rural District Council. Mr. W. A. Cooper, clerk, Council Offices, Kingsclere, near Newbury. (Fee £2 2s., returnable.)

Wallasey, December 18.—About 30 tons of 4-in., 6-in., 9-in., and 12-in. dia. British standard flange cast-iron pipes, concrete lined, for the Town Council. Mr. L. St. G. Wilkinson, borough engineer, Town Hall, Wallasey.

Richmond (Yorks), December 20.—Providing and laying about one mile of 6-in., four miles of 5-in., two miles of 4-in., seven miles of 3-in. spun-iron pipes, together with contingent works, for the Rural District Council. Messrs. F. J. Rodwell & Son, engineers, 37 and 38, Prudential Buildings, Park Row, Leeds. (Fee £3 3s., returnable.)

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Adamson & Company (Machines), Limited, 8, Cross Belgrave Street, Leeds.—Capital £3,000. Engineers and founders. Director: E. Adamson.

Sykes & Harrison, Limited, 10, Piercy Street, Ancoats, Manchester.—Capital £2,000. To acquire the business of non-ferrous founders carried on at Union Street Foundry, Ardwick, Manchester, as Sykes & Harrison; and to purchase the business of ironfounders carried on at Piercy Street, Ancoats, Manchester, as Alexander Dunn & Son. Directors: Mrs. E. A. Harrison and S. G. Harrison.

Personal

MR. C. E. WILLIAMS, Past-President of the Institute of British Foundrymen, is shortly leaving England for an extended tour of the Far East, terminating the trip in Japan.

MR. J. L. SHARPE, who left Airdrie some years ago to take up duties with the South African works of Messrs. Stewarts and Lloyds, Limited, has been appointed Mayor of the town of Vereeniging.

MR. THOMAS LANGLEY, steel-foundry foreman, of Messrs. Lake & Elliot, Limited, Braintree, is leaving after 25 years' service and joining the staff of Messrs. Babcock & Wilcox, Limited, Renfrew.

MR. MAURICE DENNY, chairman of Messrs. Denny Bros. & Company, Limited, Leven Shipyard, Dumbarton, has accepted nomination as president-elect of the Institute of Marine Engineers and will be formally elected in March.

MR. ARTHUR HENDERSON, who is an honorary member of the Institute of British Foundrymen, has been awarded the Nobel Peace Prize for 1934 for his work as President of the Disarmament Conference. The prize amounts to about £8,100.

THE HON. J. M. W. NORTH, has been appointed chairman and managing director of Messrs. John North (Founders & Engineers), Limited, 396, London Road, Isleworth, Middlesex, who will take over the business hitherto carried on by Mr. North at the same address.

Will

DAVIE, PETER CARMICHAEL, ironfounder, late of 14, Allan Park, Stirling ... £3,453

Obituary

MR. GAVIN SHAW, of Cochrane Street, Bellshill, was fatally injured in the course of his employment at Fullwood Foundry, Mossend. He fell from a travelling crane a distance of 30 ft., and death was practically instantaneous.

MR. ANDREW J. Y. TURNER died suddenly at his home at Kilmarnock. Mr. Turner, who was in his 65th year, served his apprenticeship and spent the whole of his working life in the employ of Messrs. Glenfield & Kennedy, Limited.

THE DEATH HAS OCCURRED of Mr. James Alexander Allan, in his 80th year. He joined the army at the age of 12 and was discharged in 1887, when he secured employment with Messrs. R. Y. Pickering & Company, Limited, Wishaw, and remained there until a few years ago.

MR. JOHN WALLACE LIVINGSTONE JONES, who for many years had been a well-known figure in Glasgow engineering circles, died recently. Mr. Jones, who resided in Glasgow, was associated with the underfeed stoker division of International Combustion, Limited, and had been their Glasgow office manager for more than 25 years.

A WELL-KNOWN KILMARNOCK MAN, Mr. Rankin Kennedy MacAlister, died on December 4. Mr. MacAlister, who was 75 years of age, was trained as an engineer at the old Vulcan Works in Kilmarnock and later entered the drawing office of Messrs. Grant, Ritchie & Company, Limited, Townholme Works, and in course of time became chief draughtsman. When the business was converted into a limited liability company he became a director and latterly became managing director.

Forthcoming Events

Institute of British Foundrymen

DECEMBER 14.

Middlesbrough Branch:—Report of Sub-Committee on Cast Iron of the Technical Committee, presented by W. West, at the Cleveland Scientific and Technical Institute, Corporation Road, Middlesbrough, at 7.45 p.m.

DECEMBER 15.

Newcastle-upon-Tyne Branch:—Joint meeting with the Institute of Metals. "Problems in Non-Ferrous Foundry Practice," Paper by F. W. Rowe, at the Neville Hall, Westgate Road, Newcastle-upon-Tyne, at 6.15 p.m.

Falkirk Section:—"The Patternshop: A Necessary Evil," Paper by J. Nicholson, at the Temperance Café, Lint Riggs, Falkirk, at 6 p.m.

DECEMBER 19.

London Branch:—Annual dinner, Charing Cross Hotel, W.C.2, at 7 for 7.30 p.m.

DECEMBER 21.

Lancashire Branch (Junior Section):—"Cupola Practice," Paper by J. Jackson, at the College of Technology, Sackville Street, Manchester, at 7.30 p.m.

Sheffield and District Branch:—"Further Notes on Defects in Steel Castings," Paper by C. H. Kain, at the Grand Hotel, Sheffield, at 7.45 p.m.

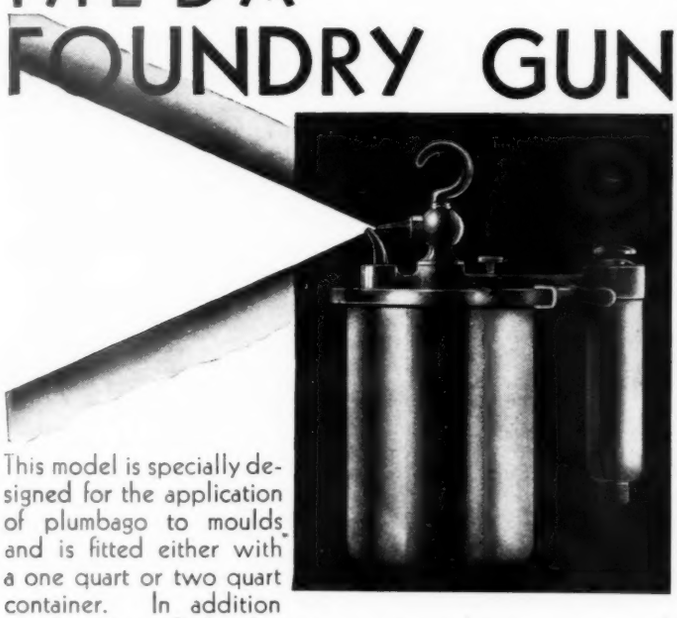
The Institute of Vitreous Enamellers

DECEMBER 14.

Southern Section:—"Sandblasting." Paper by Kenneth Hill at British Industries House, Marble Arch, London, W.1, at 8 p.m.

XUM

TYPE D·A FOUNDRY GUN



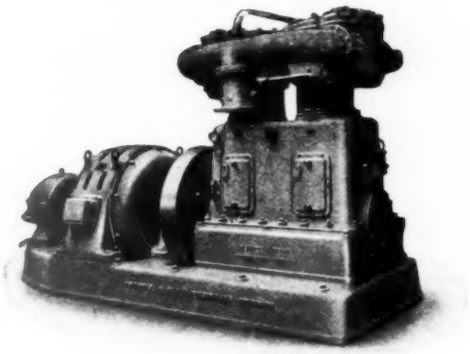
This model is specially designed for the application of plumbago to moulds and is fitted either with a one quart or two quart container. In addition to the Type D.A. there is a comprehensive range of Aerograph De Vilbiss Spray Guns, covering the whole field of spray painting and finishing. These are described and illustrated in the new Aerograph Catalogue C.L.2, which we shall be pleased to send you free of charge.

AEROGRAPH·DeVilbiss

AEROGRAPH CO. LTD., Lower Sydenham, S.E.26. City Offices: 43 Holborn Viaduct, E.C.1

CVS—71

COMPRESSORS
& DRY VACUUM PUMPS
FOR AIR OR GASES



These Vertical double-acting crosshead type compressors are built as single and two-stage machines for pressures up to 40 and 120 lbs. per sq. in. They are built in a range of sizes for capacities up to 10,000 and 5,000 cu. ft. per minute respectively.

For particulars of these machines and for other types write to :—Ref. Y.

REAVELL & CO., LTD.,
RANELAGH WORKS, IPSWICH

Telegrams: "Reavell Ipswich." 'Phone: 2124 Ipswich.

SONGS OF THE SAND.

Stanza III - THE FOREMAN MOULDER.

I always use ERITH now Sir,
The Foreman Moulder said,
I've tried every sand in the land Sir,
Sea and Yellow and Red.

I used to have trouble galore Sir,
My Castings often went west,
But now I know how to use it
The ERITH LOAM does the rest.

My labours are very much lightened
As I watch the metal glow,
And see the "CAST" emerging
Free from "SCAB" and "BLOW."

The World moves onward and onward,
And I try most things when we're brisk,
But I never monkey with Sand Sir,
I could not take the risk.

I'm getting an old man now Sir,
I'll soon finish and make more room
For the lads who follow my footsteps
And always use "ERITH LOAM."

ERITH LOAM MARKETED IN FIVE GRADES :

MILD
MEDIUM
YELLOW
STRONG
EXTRA STRONG
and
WHITE SILICA
for Oil Cores

Samples on application to :—

J. PARISH & CO.

LOAM QUARRIES,

ERITH, KENT

Raw Material Markets

Under the stimulus of increased expenditure on public works, the home demand for steel products is expected to show further expansion in the near future. In the meantime, the market retains its very firm tone. There is a steady demand for ordinary grades of pig-iron and, judging by the heavy volume of forward bookings already reported, the re-lighting of additional furnaces may have to take place earlier than was at first anticipated.

Pig-Iron

MIDDLESBROUGH.—In the Cleveland foundry-iron trade the approach of the holiday and the stock-taking period has not had such a marked influence on activity as in recent years, and there is still a number of inquiries circulating. The producers' order-books are already well filled as regards the first quarter of next year. Very heavy tonnages of iron continue to be taken by the Scottish foundries. Delivered prices for No. 3 Cleveland G.M.B. in Scotland are 67s. 3d. per ton in the Falkirk area, and 70s. 3d. in the Glasgow area, which compares with local quotations of 67s. 6d. per ton delivered Middlesbrough and 69s. 6d. delivered North-East Coast. The customary premium of 2s. 6d. per ton is charged on No. 1 foundry iron and there is a rebate of 1s. per ton on deliveries of No. 4 foundry and No. 4 forge qualities.

The demand for East Coast hematite continues to grow, and little, if any, iron is being taken into stock. Apart from the heavy requirements of consumers locally, and also in Sheffield and the Midlands, export business, with Denmark and Italy in particular, has been more active lately. Home prices are still stabilised on the basis of 69s. per ton for No. 1 hematite delivered Middlesbrough, while delivered prices in other zones are:—North-East Coast, 71s.; Scotland, 75s.; Yorkshire, 75s. to 78s.; Lancashire, 76s.; Midlands, 79s.; London, 83s. 6d. per ton. Export prices are all subject to negotiation, but about 62s. 6d. is an average figure f.o.b. Middlesbrough.

LANCASHIRE.—The customary seasonal slackening has been witnessed in some of the light-castings foundries, but activity is otherwise well maintained for the time of year, and ironmasters express themselves as satisfied with the rate at which iron is going into consumption. Current offers of Staffordshire, Derbyshire and Lancashire brands of No. 3 common iron are all on the basis of 74s. per ton for delivery to Lancashire foundries, with Northants at 72s. 6d., Derbyshire forge iron at 69s., Scottish foundry at about 82s. 6d., East Coast hematite at from 75s. to 76s., according to quality, and West Coast hematite at around 78s. 6d.

MIDLANDS.—As previously reported, several of the biggest light-castings foundries in this area have not been working full time, and do not expect to be really busy again until the early spring demand sets in for castings for the building trade. With this exception, there is still quite a good demand for common grades of iron from Midlands users. Prices are 67s. 6d. per ton for No. 3 Northants and 71s. for Derbyshire, Lincolnshire and North Staffordshire No. 3, including delivery to Birmingham and Black Country stations, and also subject to rebate to large consumers. With regard to pig-iron for the general engineering trades, in addition to the irons mentioned previously, better grades are being used in increased quantities. Medium-phosphorus irons vary between 72s. 6d. and 80s., with low-phosphorus, including Scottish No. 3, at 85s. 6d. to 87s. 6d., and special refined pig at £5 7s. 6d. to £6 10s. per ton, delivered this area. With regard to hematite pig-iron, so far there has been little buying activity. There is no sign of any alteration in prices.

SCOTLAND.—The demand for Scottish foundry iron is still limited, and some iron is having to be put into stock. The official price remains at 70s. f.o.t. furnaces for No. 3 grade, with 2s. 6d. extra for No. 1. Cleveland No. 3 is still quoted at 67s. 3d. f.o.t. Falkirk and 70s. 3d. f.o.t. Glasgow, other English foundry iron being 1s. 3d. per ton less.

Coke

The situation in the foundry-coke market presents no change. Consumers have mostly contracted ahead over the winter period, and orders for delivery are coming forward at a steady and satisfactory rate. Current quotations for delivery in the Midlands are as follow:—Best Durham fuel, 36s. to 40s.; secondary grades, 34s. to 35s. 6d.; Welsh coke, 35s. to 45s.; Scottish, 40s. to 41s. per ton.

Steel

The markets have entered the period of quiet trading which usually develops at this time of the year. Although the volume of new business has declined, the works in most departments are well provided with orders, and heavy deliveries are being made to the consuming trades. Business in semi-finished steel has declined, most consumers having covered their requirements for some time to come. The makers, however, have good contracts in hand and production is at a high level. Although fair quantities of Continental material continue to be sold in this country, the great bulk of the business is taken by the home works. The demand for finished-steel materials is well maintained, and where a decline in the volume of business is noticeable it is usually due to seasonal causes. Steady conditions rule in the export market and the general tendency is for the overseas demand to expand.

Scrap

In the Cleveland area, prices realised for cast-iron scrap are somewhat irregular, but still show an upward tendency. Ordinary cast-iron scrap is at 51s. 6d. to 53s. per ton and machinery metal at 53s. 6d. to 55s. There is a very steady demand for cast-iron scrap in the Midlands at unchanged prices, i.e., 55s. for heavy machinery metal, 50s. for good heavy, and 47s. 6d. for light metal. In Scotland there is a good demand for clean machinery scrap at 56s. to 57s., with ordinary cast-iron at 52s. 6d. There is a fairly good call for both heavy and light cast-iron scrap in South Wales, but the demand for machinery grade remains limited.

Metals

Copper.—Greater interest has been taken in this market lately, and the general tone is distinctly more optimistic. This change is attributed to the more cheerful reports as to industrial activity in the United States, and the slightly better outlook in European affairs.

It is stated unofficially that a general meeting of world copper producers will take place in New York on January 15, to discuss proposals for the curtailment of outputs. What the outcome of the meeting will be, it is impossible to forecast at this date.

Daily market prices:—

Cash.—Thursday, £27 10s. to £27 12s. 6d.; Friday, £27 16s. 3d. to £27 17s. 6d.; Monday, £27 15s. to £27 17s. 6d.; Tuesday, £27 15s. to £27 17s. 6d.; Wednesday, £27 13s. 9d. to £27 15s.

Three Months.—Thursday, £27 17s. 6d. to £27 18s. 9d.; Friday, £28 3s. 9d. to £28 5s.; Monday, £28 2s. 6d. to £28 3s. 9d.; Tuesday, £28 2s. 6d. to £28 3s. 9d.; Wednesday, £28 1s. 3d. to £28 2s. 6d.

Tin.—The tin market has had a very steady tone, and conditions are likely to remain stable for some time ahead. Production in the opening months of 1935 is to remain at the current level, and there is little probability of any sudden fluctuation in the demand, either one way or the other.

"Demand on the part of consumers in this country continues satisfactory, and a moderate business is reported on the Continent, whilst in the United States of America, with indications of gradually returning confidence, some improvement in this direction has taken place," report Messrs. Rudolf Wolff.

Price fluctuations:—

Cash.—Thursday, £227 15s. to £227 17s. 6d.; Friday, £228 5s. to £228 7s. 6d.; Monday, £228 10s. to £228 12s. 6d.; Tuesday, £228 5s. to £228 7s. 6d.; Wednesday, £228 10s. to £228 12s. 6d.

Three Months.—Thursday, £228 15s. to £228 17s. 6d.; Friday, £228 17s. 6d. to £229; Monday, £228 12s. 6d. to £228 15s.; Tuesday, £228 10s. to £228 12s. 6d.; Wednesday, £228 10s. to £228 12s. 6d.

Spelter.—The demand for spelter in this country is quite good. There have lately been signs of some re-awakening in the galvanising trade, but activity in this direction is still very limited. The London market has been without any development of note. Prices seem to have touched rock-bottom, and have remained steady at the level of the past few weeks.

Day-to-day quotations:—

Ordinary.—Thursday, £11 16s. 3d.; Friday, £11 16s. 3d.; Monday, £11 15s.; Tuesday, £11 13s. 9d.; Wednesday, £11 13s. 9d.

Lead.—The price of lead shows no sign of rising from its present low level. There is quite a strong demand from consumers in this country, and the scarcity of Empire brands continues, but the abundance of supplies from other sources continues to depress the market.

Price fluctuations have been as follow:—

Soft Foreign (Prompt).—Thursday, £10 6s. 3d.; Friday, £10 7s. 6d.; Monday, £10 6s. 3d.; Tuesday, £10 2s. 6d.; Wednesday, £10 2s. 6d.

We pay the highest prices for TIN, WHITE METAL, SOLDER, LEAD AND TYPE METAL.
In the form of SCRAP, SKIMMINGS, SLAGS, DROSS, RESIDUES, SWEEPINGS, ASHES, BY-PRODUCTS, Etc.
SELL TO US YOU WILL BE SATISFIED.
WE ARE ACTUAL SMELTERS.
SEND US SAMPLES AND PARTICULARS OF YOUR ACCUMULATION
INTERNATIONAL SMELTERS LTD.
CHRISTCHURCH ROAD,
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Telephone: Mitcham 2131. Telegrams: "Intasmelta, Phone, London."

THOS. GADD,
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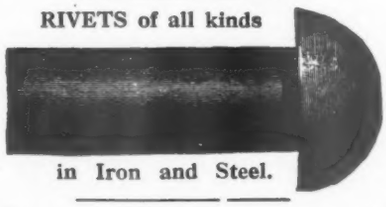
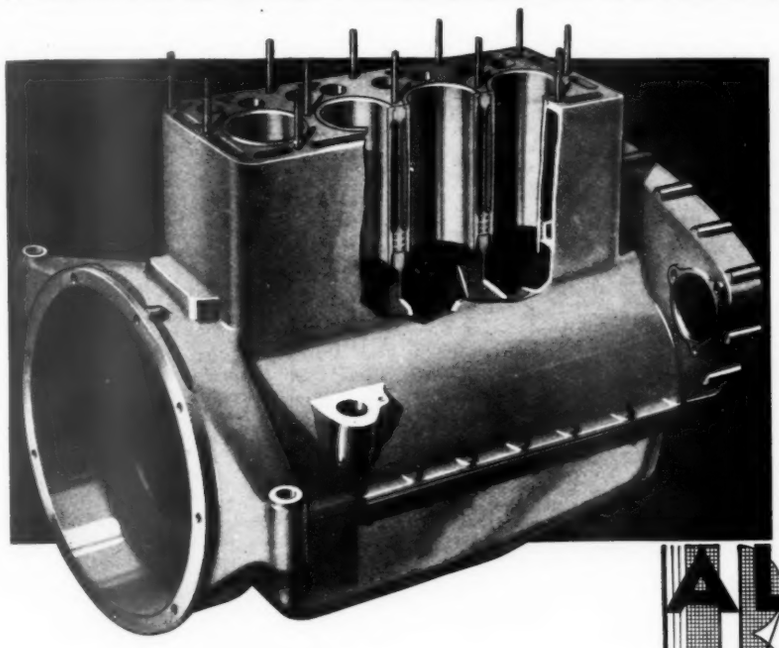
ROWLEY REGIS, near BIRMINGHAM.
RIVETS of all kinds

in Iron and Steel.
Telegrams: "Thos. Gadd, Rowley Regis."
Telephone: Blackheath 1020.
Established 1830.



4 ADVANTAGES of ALUMINIUM for Cylinder Blocks

1. Reduction of at least 50% in the block weight, giving increased power to weight ratio, which may be applied to give reduced chassis weight or improved payload.
2. Good thermal properties.
3. Reduction of scaling and deposits in the jackets.
4. Good machining properties and a high value of machine swarf and scrap material which considerably offsets extra initial cost of metal.

LONDON WAREHOUSE: 25-29, Pancras Road, N.W.1.
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The BRITISH ALUMINIUM CO. Ltd.
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BARROW IRON

OPEN HEARTH REFINED
REFINED CUPOLA
WEST COAST HÆMATITE

Also SEMI-PHOSPHORIC
for Motor Cylinders, Valve Bodies, Steam and Hydraulic Castings, Etc.

LONDON OFFICE:
59, VICTORIA ST., S.W.1.

THE BARROW HÆMATITE STEEL CO., LTD., BARROW-IN-FURNESS. LANCS.

RAW MATERIALS—PRICE LIST

(Wednesday, December 12, 1934)

COPPER

	£	s.	d.
Standard cash	27	13	9
Three months	28	1	3
Electrolytic	31	0	0
Tough	29	15	0
Best selected	30	5	0
Sheets	58	0	0
India	40	15	0
Wire bars	31	7	6
Ingot bars	31	7	6
H.C. wire rods	34	2	6
Off. av. cash, November	27	5	5 5/11
Do., 3 mths., November	27	12	0 3/11
Do., Sttlmnt., November	27	5	5 5/11
Do., Electro, November	30	10	4 7/11
Do., B.S., November	30	3	7 1/11
Do., wire bars, November	30	16	4 4/11
Solid drawn tubes			9½d.
Brazed tubes			9½d.
Wire			6d.

BRASS

Solid drawn tubes	8¾d.
Brazed tubes	10¾d.
Rods, drawn	8d.
Rods, extd. or rlld.	4¼d.
Sheets to 10 w.g.	7d.
Wire	7d.
Rolled metal	6½d.
Yellow metal rods	4¼d.
Do. 4 × 4 Squares	5½d.
Do. 4 × 3 Sheets	5½d.

TIN

	£	s.	d.
Standard cash	228	10	0
Three months	228	10	0
English	228	12	6
Bars	230	12	6
Straits	230	10	0
Australian (nom.)			—
Eastern	231	7	6
Banca	230	2	6
Off. av. cash, November	228	13	4 10/11
Do., 3 mths., November	228	16	0 3/11
Do., Sttlmt., November	228	13	10 8/11

SPELTER

	£	s.	d.
Ordinary	11	13	9
Remelted	12	15	0
Hard	10	5	0
Electro 99.9	14	5	0
English	12	15	0
India	11	15	0
Zinc dust	17	0	0
Zinc ashes	3	0	0
Off. aver., November	12	2	9¾
Aver. spot, November	12	0	0

LEAD

	£	s.	d.
Soft foreign ppt.	10	2	6
Empire (nom.)	11	7	6
English	12	10	0
Off. average, November	10	10	3 3/11
Average spot, November	10	8	7 8/11

ALUMINIUM

Ingots	£100 to £105
Wire	1/1 to 1/9 lb.
Sheet and foil	1/2 to 2/9 lb.

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	23	10	0
Do., V.M. ex whse.	23	0	0
Rods	26	10	0

ANTIMONY

	£	s.	d.
English	65	0	0
Chinese, ex-whse.	59	0	0
Crude		—	

QUICKSILVER

	£	s.	d.		£	s.	d.
Quicksilver	11	2	6	to	11	10	0

FERRO-ALLOYS AND STEEL-MAKING METALS

	£	s.	d.		£	s.	d.
Ferro-silicon—							
25%	8	17	6				
45/50%	13	0	0				
75%	18	7	6				
Ferro-vanadium—							
35/50	12/8 lb. Va.						
Ferro-molybdenum—							
70/75% carbon-free	5/3 lb. Mo.						
Ferro-titanium—							
23/25% carbon-free	9d. lb.						
Ferro-phosphorus, 20/25%	£14	10	0				
Ferro-tungsten—							
80/85%	3/- lb.						
Tungsten metal powder—							
98/99%	3/3 lb.						
Ferro-chrome—							
2/4% car.	29	15	0				
4/6% car.	23	0	0				
6/8% car.	21	12	6				
8/10% car.	21	12	6				
Ferro-chrome—							
Max. 2% car.	34	0	0				
Max. 1% car.	38	15	0				
Max. 0.70% car.	42	0	0				
70% carbon-free	10d. lb.						
Nickel—99.5/100%	£200 to £205						
"F" nickel shot	£184	0	0				
Ferro-cobalt, 98/99%	5/3 lb.						
Metallic chromium—							
96/98%	2/5 lb.						
Ferro-manganese (net)—							
76/80% loose	£10	15	0	to £11	5	0	
76/80% packed	£11	15	0	to £12	5	0	
76/80% export (nom.)	£9	15	0				
Metallic manganese—							
94/96% carbon-free	1/2 lb.						

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 1/8 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ¼ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

South Wales—	£	s.	d.		£	s.	d.
Heavy steel	2	15	0	to	2	16	0
Bundled shrngs.					2	7	6
Mixed iron and steel	2	10	0	to	2	12	0
Heavy cast iron	2	10	0	to	2	12	6
Good machinery	2	12	6	to	2	15	0
Cleveland—							
Heavy steel	2	11	0	to	2	12	6
Steel turnings					1	15	0
Cast-iron borings					1	5	0
Heavy cast iron					2	12	6
Heavy machinery					2	13	6
Midlands—							
Light cast-iron scrap					2	7	6
Heavy wrought iron					3	0	0
Steel turnings, f.o.r.					1	14	0
Scotland—							
Heavy steel					2	10	0
Ordinary cast iron					2	12	6
Engineers' turnings					1	19	6
Cast-iron borings					1	17	6
Wrought-iron piling					2	11	3
Heavy machinery					2	16	6

London—Merchants' buying prices, delivered yard.

	£	s.	d.
Copper (clean)	24	0	0
Brass	16	0	0
Lead (less usual draft)	9	10	0
Tea lead	7	0	0
Zinc	8	10	0
New aluminium cuttings	66	0	0
Braziery copper	19	0	0
Gunmetal	22	0	0
Hollow pewter	155	0	0
Shaped black pewter	115	0	0

PIG-IRON

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	70/-
Foundry No. 3	67/6
,, at Falkirk	67/3
,, at Glasgow	70/3
Foundry No. 4	66/6
Forge No. 4	66/6
Hematite No. 1	69/-
Hematite M/Nos.	68/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	72/6
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	67/-
,, No. 3 fdry.	71/-
Northants forge	63/6
,, fdry. No. 3	67/6
,, fdry. No. 1	70/6
Derbyshire forge	67/-
,, fdry. No. 3	71/-
,, fdry. No. 1	74/-
Scotland—	
Foundry No. 1, f.o.t.	72/6
,, No. 3, f.o.t.	70/-
Hem. M/Nos. d d	71/-
Sheffield (d/d district)—	
Derby forge	64/6
,, fdry. No. 3	68/6
Lincs forge	64/6
,, fdry. No. 3	68/6
E.C. hematite	81/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	74/-
Staffs fdry. No. 3	74/-
Northants fdry. No. 3	72/6
Cleveland fdry. No. 3	74/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	82/6
Clyde, No. 3	82/6
Monkland, No. 3	82/6
Summerlee, No. 3	82/6
Eglinton, No. 3	82/6
Gartsherrie, No. 3	82/6
Shotts, No. 3	82/6

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£	s.	d.		£	s.	d.
Bars (cr.)	9	12	6	to	9	15	0
Nut and bolt iron	7	10	0	to	8	0	0
Hoops	10	10	0	and up.			
Marked bars (Staffs) f.o.t.	12	0	0				
Gas strip	10	10	0	and up.			
Bolts and nuts, ¾ in. × 4 in.	15	0	0				
Steel—							
Plates, ship, etc.	8	15	0	to	8	17	6
Boiler plts.	9	5	0	to	9	7	6
Chequer plts.					10	7	6
Angles					8	7	6
Tees					9	7	6
Joists					8	15	0
Rounds and squares, 3 in. to 5½ in.					9	7	6
Rounds under 3 in. to ⅜ in. (Untested)					8	12	0
Flats—8 in. wide and over					8	12	6
,, under 8 in. and over 5 in.					8	17	6
Rails, heavy	8	5	0	to	8	10	0
Fishplates	12	5	0	to	12	10	0
Hoops (Staffs)					9	7	0
Black sheets, 24g. (4-t. lots)					10	10	0
Galv. cor. shts. (,,)					13	0	0
Galv. flat shts. (,,)					13	10	0
Galv. fencing wire, 8g. plain					14	10	0
Billets, soft	5	10	0	and up.			
Billets, hard	6	17	6	to	7	2	6
Sheet bars	5	0	0	to	5	7	6
Tin bars	5	2	6	to	5	7	6

PHOSPHOR BRONZE

	Per lb. basis
Strip	9d.
Sheet to 10 w.g.	10d.
Wire	11d.
Rods	10d.
Tubes	13d.
Castings	10½d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	20.26
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	14.50
Basic, Valley	18.00
Bessemer	20.76
Malleable, Valley	18.50
Grey forge, Valley	18.00
Ferro-mang. 80%, seaboard	85.00
O.-h. rails, h'y, at mill	36.37½
Billets	27.00
Sheet bars	28.00
Wire rods	38.00
	Cents.
Iron bars, Chicago	1.80
Steel bars	1.80
Tank plates	1.80
Beams, etc.	1.80
Skelp, grooved steel	1.70
Steel hoops	2.10
Sheets, black, No. 24	2.40
Sheets, galv., No. 24	3.10
Wire nails	2.60
Plain wire	2.30
Barbed wire, galv.	3.00
Tinplates, 100-lb. box	$5.25

COKE (at ovens)

Welsh foundry	25/- to 30/-
,, furnace	19/- to 20/-
Durham foundry	20/- to 25/-
,, furnace	17/6
Midlands, foundry	—
,, furnace	—

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box	18/2 to 18/6
,,	28×20 ,,	36/4 to 37/-
,,	20×10 ,,	26/- to 26/3
,,	18¾×14 ,,	18/9 to 19/-
C.W.	20×14 ,,	15/9 to 16/6
,,	28×20 ,,	33/6 to 34/-
,,	20×10 ,,	23/9 to 24/-
,,	18¾×14 ,,	16/-

SWEDISH CHARCOAL IRON & STEEL

	£	s.	d.		£	s.	d.
Pig-iron	£6	0	0	to	£7	0	0
Bars-hammered, basis	£16	0	0	to	£16	10	0
Bars and nail-rods, rolled, basis	£15	15	0	to	£16	0	0
Blooms	£10	0	0	to	£12	0	0
Keg steel	£30	0	0	to	£31	0	0
Faggot steel	£18	0	0	to	£23	0	0
Bars and rods dead soft, st'l	£10	0	0	to	£12	0	0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

		£ s. d.	
Dec.	6 ..	27 10 0	inc. 6/3
,,	7 ..	27 16 3	,, 6/3
,,	10 ..	27 15 0	dec. 1/3
,,	11 ..	27 15 0	No change
,,	12 ..	27 13 9	dec. 1/3

Electrolytic Copper

		£ s. d.	
Dec.	6 ..	30 10 0	No change
,,	7 ..	31 0 0	inc. 10/-
,,	10 ..	31 0 0	No change
,,	11 ..	31 0 0	,, ,,
,,	12 ..	31 0 0	,, ,,

Standard Tin (cash)

		£ s. d.	
Dec.	6 ..	227 15 0	dec. 12/6
,,	7 ..	228 5 0	inc. 10/-
,,	10 ..	228 10 0	,, 5/-
,,	11 ..	228 5 0	dec. 5/-
,,	12 ..	228 10 0	inc. 5/-

Tin (English ingots)

		£ s. d.	
Dec.	6 ..	227 17 6	dec. 15/-
,,	7 ..	228 7 6	inc. 10/-
,,	10 ..	228 12 6	,, 5/-
,,	11 ..	228 7 6	dec. 5/-
,,	12 ..	228 12 6	inc. 5/-

Spelter (ordinary)

		£ s. d.	
Dec.	6 ..	11 16 3	No change
,,	7 ..	11 16 3	,, ,,
,,	10 ..	11 15 0	dec. 1/3
,,	11 ..	11 13 9	,, 1/3
,,	12 ..	11 13 9	No change

Spelter (Electro, 99.9 per cent.)

		£ s. d.	
Dec.	6 ..	14 10 0	inc. 1/3
,,	7 ..	14 10 0	No change
,,	10 ..	14 7 6	dec. 2/6
,,	11 ..	14 5 0	,, 2/6
,,	12 ..	14 5 0	No change

Zinc Sheets (English)

		£ s. d.	
Dec.	6 ..	23 10 0	No change
,,	7 ..	23 10 0	,, ,,
,,	10 ..	23 10 0	,, ,,
,,	11 ..	23 10 0	,, ,,
,,	12 ..	23 10 0	,, ,,

Lead (English)

		£ s. d.	
Dec.	6 ..	12 10 0	No change
,,	7 ..	12 10 0	,, ,,
,,	10 ..	12 10 0	,, ,,
,,	11 .	12 10 0	,, ,,
,,	12 ..	12 10 0	,, ,,

AVERAGE MONTHLY PRICES OF STEEL BOILER PLATES IN ENGLAND

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1897	6 10 0	6 10 0	6 10 0	6 7 6	6 2 6	6 2 6	6 5 0	6 0 0	6 0 0	6 0 0	6 7 6	6 10 0	6 5 5
1898	6 10 0	6 8 9	6 8 9	6 10 0	6 15 0	6 18 9	6 17 6	6 17 6	7 2 6	6 15 0	7 0 0	7 5 0	6 15 8½
1899	7 5 0	8 0 0	8 2 6	8 2 6	8 5 0	8 5 0	8 12 6	8 12 6	8 15 0	8 15 0	9 2 6	9 5 0	8 17 8½
1900	9 5 0	9 5 0	9 7 6	9 10 0	9 12 6	10 5 0	10 5 0	10 5 0	10 5 0	10 0 0	9 15 0	9 15 0	9 15 10
1901	9 5 0	9 5 0	8 15 0	8 10 0	8 10 0	7 10 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	8 3 11
1902	7 7 6	7 0 0	7 12 6	7 12 6	7 12 6	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 9 7
1903	7 10 0	7 10 0	7 15 0	7 5 0	7 5 0	7 5 0	7 5 0	7 0 0	7 0 0	7 0 0	7 0 0	6 17 6	7 3 11½
1904	6 12 6	6 15 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	6 18 11½
1905	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 10 0	7 5 0	8 0 0	8 0 0	7 1 3
1906	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 10 0	8 0 10
1907	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 0 0	8 0 0	8 8 4
1908	7 10 0	7 10 0	7 10 0	7 5 0	7 5 0	7 5 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 3 9
1909	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	6 15 0	6 15 0	6 15 0	7 0 0	7 0 0	7 0 0	7 0 0	6 18 9
1910	7 0 0	7 0 0	7 1 3	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 10 0	7 10 0	7 10 0	7 5 1
1911	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 14 0	7 10 4
1912	7 18 9	8 0 0	8 0 0	8 7 6	8 10 0	8 10 0	8 10 0	8 15 0	8 16 3	9 0 0	9 2 0	9 5 0	8 11 2½
1913	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	8 19 0	8 15 0	8 5 0	7 15 0	7 15 0	8 17 0
1914	7 15 0	7 15 0	7 15 0	7 13 9	7 10 6	7 5 0	7 0 0	8 0 0	8 2 6	8 5 0	8 5 0	8 5 0	7 15 11½
1915	8 14 0	9 10 0	9 17 6	10 10 0	10 10 0	11 0 0	11 0 0	11 0 0	11 0 0	11 4 0	12 0 0	13 0 0	10 15 5½
1916	13 0 0	13 0 0	13 0 0	12 15 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 12 11
1917	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0
1918	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0
1919	13 0 0	15 0 0	15 0 0	15 0 0	19 5 0	19 17 6	21 0 0	21 10 0	21 10 0	21 10 0	21 15 0	23 10 0	18 9 9
1920	26 0 0	28 0 0	28 5 0	28 10 0	29 5 0	30 0 0	30 0 0	30 0 0	30 10 0	31 0 0	31 0 0	31 0 0	29 9 2
1921	30 5 0	29 0 0	25 0 0	25 0 0	25 0 0	23 0 0	21 0 0	20 10 0	19 0 0	17 10 0	16 0 0	14 16 0	22 1 9
1922	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	13 1 8	13 10 0	12 15 0	12 10 0	12 10 0	12 10 0	12 6 0	13 10 9
1923	12 8 9	13 6 0	14 0 0	14 0 0	14 0 0	14 0 0	13 12 6	13 0 0	13 0 0	13 0 0	13 0 0	13 10 0	13 9 1½
1924	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	14 0 0	14 0 0	13 11 0	13 5 0	13 5 0	13 10 11
1925	13 5 0	13 5 0	13 5 0	13 1 0	12 15 0	12 15 0	12 15 0	12 15 0	12 7 6	11 14 0	11 10 0	11 10 0	12 11 5½
1926	11 10 0	11 10 0	11 10 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 6 3
1927	11 5 0	11 5 0	11 5 0	11 5 0	11 2 6	11 0 0	11 0 0	11 0 0	10 16 0	10 10 0	10 10 0	10 10 0	10 19 0½
1928	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0
1929	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 5 0	10 1 3	10 1 3	10 1 3	10 1 7	10 6 8½
1930	10 2 9	10 3 5½	10 3 9	10 3 9	10 3 6	10 2 6	10 2 6	10 2 6	10 2 2½	9 19 6	9 16 3	9 16 3	10 1 6½
1931	9 15 0	9 15 0	9 15 0	9 10 11	9 6 9	9 5 0	9 7 0	9 7 9½	9 8 9	9 5 9	9 5 6	9 9 6	9 9 4
1932	9 5 0	9 2 6	8 18 6	8 17 6	8 16 6½	8 16 3	8 16 3	8 16 3	8 16 3	8 16 3	8 16 3	8 16 3	8 17 10
1933	8 10 0	8 10 0	8 10 0	8 8 9	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	8 6 0	8 7 6	8 6 1½
1934	8 8 1½	8 10 7½	8 16 6	8 17 6	8 6 3	8 6 3	8 5 7½	8 5 0	8 5 0	8 5 0	9 6 3	—	—

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CHANGE OF APPOINTMENT DESIRED BY CHIEF CHEMIST with many years' experience as Works Manager for well-known English firm, in charge of manufacture and application of all classes of Vitreous Enamels for domestic purposes and for the chemical industries. Expert in enamel manufacture and design of plant.—Box 988, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

REPRESENTATIVES required throughout Great Britain for marketing chemical device applied by metal and iron founders. Liberal commission only.—Write, Box ZX 175, c/o DEACONS, 5, St. Mary Axe, London, E.C.3.

EMPLOYMENT REGISTER.

Conducted by the Institute of British Foundrymen by courtesy of the proprietors of THE FOUNDRY TRADE JOURNAL.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

Any employer wishing to communicate with a candidate should write to the General Secretary, quoting identification number.

FOUNDRY Foreman requires position. Excellent experience with high-class work, including repetition work and moulding machines. Metal-mixing. Accustomed to modern foundry plant, estimating and costing. (251)

STEEL-FOUNDRY Chemist and Metallurgist desires change. Also had steelworks experience. Thorough knowledge electric-furnace practice, alloy steels, heat-treatment. (252)

TENDER

GREAT WESTERN RAILWAY.

THE Directors of this Company are prepared to receive Tenders for the supply, from February 1, 1935, of the undermentioned Iron and Steel Goods :—

3.—Tyres and Rolled-Steel Wheel Centres.
4.—Steel Axles and Forgings.
5.—Iron Bars and Plates.
6.—Steel Plates and Sheets.
7.—Steel Bars and Blooms.
8.—Steel Castings (Wheel Centres).
9.— Ditto (Miscellaneous).
11.—Chain.
12.—Tubes and Fittings (Gas, Steam, Electric Conduit, etc.).
13.—Weldless Steel Tubes (Steam and H.P. Gas, Boiler, etc.).
14.—Iron Castings, Pipes, etc.
15.—Galvanised Sheets.

Specifications and Forms of Tender (upon which alone Tenders will be received) may be obtained on application to the Stores Superintendent at Swindon.

Tenders, addressed to the undersigned and marked outside "Tender for Iron and Steel," will be received not later than 10 a.m. on Tuesday, January 1, 1935.

The Directors do not bind themselves to accept the lowest or any Tender.

F. R. E. DAVIS,
Secretary.

Paddington Station,
London, W.2.
December 11, 1934.

PUBLICATION

RYLAND'S DIRECTORY of the Coal, Iron, Steel, Tinplate, Metal, Engineering, Hardware and Allied Trades. 1934 edition. Price 42s. cloth bound, 52s. morocco. Order *YOUR* copy *NOW*.—INDUSTRIAL NEWSPAPERS, LIMITED, 49, Wellington Street, Strand, London, W.C.2.

MACHINERY

FOR Sale, surplus to requirements, two E.R.3 type Universal Roll-over Moulding Machines, Hydraulic Squeeze, in new condition, pressure 10 tons at 750 lbs. per sq. in., available height between table and ramming plate 2 ft. 0¾ in., stroke of ramming piston 11⅛ in., stroke of drawing piston 4 in. Will take boxes up to 31½ in. long x 21¼ in. wide. Price of machines, £100 each, f.o.r.—WILLEY & COMPANY, LIMITED, Engineers, Exeter.

LADLES—IN STOCK.

25-Ton Stevenson.
20-Ton Stevenson.
16-Ton Stevenson.
15-Ton Stevenson.
12-Ton Evans.
10-Ton Evans.
8-Ton Evans.
6-Ton Evans.
5-Ton Evans.
Forty smaller Ladles in Stock.

A. HAMMOND,
Foundry Machinery Merchant, Slough.

3½-TON Brackelsberg Rotary Furnace, complete with equipment, equal to new. Tilghman 12-ft. x 9-ft. Sand-Blast Room, with exhauster and equipment. Above lying at Lowmoor Foundry.—Communicate with ALEX. HAMMOND, Foundry Machinery Merchant, Slough.

ONE Britannia No. 4 latest-type Jolt Roll-over Moulding Machine, largest size, with pattern plate 6 ft. 6 in. by 4 ft., giving about 20 in. clear draw; practically new condition, lying at Keighley. This machine is as new, and will be sold cheaply to avoid bringing to Slough stock.—If interested please write to: ALEX. HAMMOND, Foundry Machinery Merchant, 14, Australia Road, Slough.

NEW Dwarf Cupola, to melt 10 to 15 cwts. per hr. New Worm-geared Ladles, 5 tons, 25 cwts., 15 cwts. and 10 cwts. capacity. Ungeared Ladles, 15 cwts. and 10 cwts. capacity. Improved Cupola Spark Arresters.—T. DAVIES & SON, West Gorton, Manchester.

SANDBLAST PLANTS

Room Plants, sizes 12 ft. x 12 ft., 12 ft. x 9 ft. and 6 ft. x 6 ft., made up in cast-iron sections.

Barrel Plants, 30 in. dia. x 36 in. long and 30 in. dia. x 18 in. long rotary barrels.

Cabinet Plants, in sizes 4 ft. x 4 ft. x 4 ft., 36-in. dia. and 30-in. dia. operators' cabinets.

Most of the above by Tilghman and complete with Air Compressors.

HAND MOULDING MACHINES

By Adaptable, Pridmore, Darling & Sellars, etc.; Squeezers by Utard (unused), Samuelson and Britannia, also Farwell Universal Type.

Ladles, Grinding Machines, Exhaust Fans, Blowers, Air Compressors and 500 Electric Motors and Dynamos.

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THOS. W. WARD LTD.

30-ton Open-sided Geared POWER PRESS; 2½" str.; bolster 14" x 11"; back to table 7"; 30" dia. flywheel.

28,000 cub. ft. TURBO BLOWER, 10 lbs. press.; output 1,220 h.p. at 2,700 revs.; air and circul. pumps.

3 LANCS. BOILERS, 30' x 8', 150 lbs. w.p.

3,500' 1¼" New Black Steel S. & S. PIPING, lengths 18' and up.

Write for "Albion" Catalogue.

'Grams: "Forward." 'Phone: 23001 (10 lines).

ALBION WORKS, SHEFFIELD.

MACHINERY—*Continued*

TILGHMAN High-Pressure 9-ft. x 6-ft. Shot Blast Room Plant, complete with High-Pressure Apparatus; Double-acting, Vertical Air Compressor; Rigid-screen type Dust Arrester and Exhausting Fan. Bargain.—Write, Box 990, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUR Osborn Jolt Press Moulding Machines, Type J.75, in perfect condition, cheap.—Write: ALEX. HAMMOND, Foundry Machinery Merchant, 14, Australia Road, Slough.

FOR Sale, 10-ton Morris 3-motor Travelling Crane, span 17 ft. 7¾ in., £80. 7½-ton Overhead Hand Travelling Crane, 16 ft. 6 in., £30. Both delivered any station. Acceptance and inspection at South Bank.—Apply, E. HIND, Imperial Works, South Bank.

MISCELLANEOUS

FLUIDITY TESTS as described in THE FOUNDRY TRADE JOURNAL, February 1, 1934. Patterns of the above in aluminium can be supplied for 35s. per set. Post free. We can also supply Patterns for all branches of the engineering trade, in hard or soft woods. Send us your inquiries.—FURMSTON & LAWLOR, Patternmakers, Letchworth, Herts.

TRY our IRON CEMENT, WAX CORE VENTS and PARTING POWDER. "The right articles at the right prices"—carriage paid and quick despatch!—WM. OLSEN, LIMITED, 68, Cogan Street, Hull.

Phone: 4044.

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406 OSBORN jolt rollover.
18"×36" TABOR rollover shockless (portable).
40"×30" TABOR rollover shockless.
TWO BRITANNIA No. 1 jolters.

HAND Machines taken in part payment for above or exchanged.

SANDBLAST PLANTS

12' × 9' Tilghman sandblast room, built of cast iron plates, complete with 400 cu. ft. Tilghman air compressor and all accessories.
T.B. 4 Tilghman sandblast barrel plant, complete. Size of barrel 60" × 40".
T.B. 1 Tilghman sandblast barrel.
Small Tilghman rotary table sandblast.

BUY FROM ME AND SAVE MONEY!

ALEX. HAMMOND, *Foundry Machinery Merchant,*
14, AUSTRALIA ROAD, SLOUGH

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